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Popular Science

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OZONE:
WHY THE
DEBATE?

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SATURN

ASA
launches
the Next
planetary
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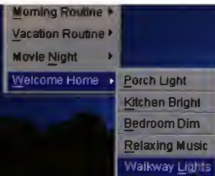
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IT HAS IN COMMON WITH
**THE TYPICAL
50-YEAR-OLD**
IS THE SPARE TIRE.



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IBM

OCTOBER 1997

COVER ART

DON FOLEY

Pocket PC Photo:
JOHN B. CARNETT

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Reports on the death of personal digital assistants were apparently premature.

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60 COVER STORY Reaching for the Rings On the heels of Pathfinder's success on Mars, the Cassini spacecraft begins its journey to Saturn and its moons this month.

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Living comfortably without connections to electric or water utilities.

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82 Head of the Family We test-drive the Chevy Malibu, Ford Taurus, Honda Accord, and Toyota Camry sedans.

92 5-Year New Car Preview Our love affair with trucks continues as alternative-fuel vehicles loom in the distance. And VW's beloved **UNIVERSITY OF MICHIGAN**

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NOV 14 1997

MEDIA UNION

The size of the screen is misleading—
this is not a laptop.



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Introducing the HP 320LX palmtop PC. With a 640 x 240 VGA screen, it's the widest of any handheld PC. Six inches. And it's the first palmtop with Microsoft® Windows® CE and a built-in CompactFlash card slot for removable memory storage. You can pull the

Designed for



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FROM THE EDITOR-IN-CHIEF

A Universe of Science



DEBATE CAN BE INVIGORATING, AND IS necessary in a democracy. But the issue of harm being inflicted on Earth's ozone layer is indisputable. Despite the overwhelming weight of scientific evidence, a handful of contrarian scientists are seeking to overturn bans on ozone-destroying chemicals and thwart efforts to further reduce the possibility of ozone depletion. "Attack on Ozone Science" by Science Editor Emeritus Arthur Fisher states the facts clearly: The time for debate is over.

Well beyond Earth's stratosphere, another scientific drama takes place this month. Cassini, the biggest, best, and last of NASA's super-spaceships, begins an audacious seven-year journey to Saturn. In "Reaching for the Rings," Contributing Editor Jim Scheffer previews the flight.

Back here on Earth, PDAs, the souped-up organizers that fell victim to hype and unfulfilled promise back in 1992, were resurrected last year with U.S. Robotics' Pilot. Now a slew of new PDAs are ready to help you work. Online Editor Suzanne Kantra Kirschner tells why this batch may include one that's just right for you. —*Fred Abatemarco*

DVD Debate

PARENTS WILL appreciate one DVD feature: the ability to place restrictions on titles ["DVD Delivers," Aug.]. If a kid pops an R-rated flick into a DVD player programmed not to show anything rated over PG-13, one of two things could happen: The movie will either not play without a password, or it will only play the PG-13 version, by skipping over the R-rated sections. The kid may not even notice.

David Eckard
swordedg@ntrnet.net

YOU SAY THAT the "chapter" feature is more curious than useful. This is similar to the "track" feature on CD players. I look forward to being able to re-run a particular scene from a movie. Arguably, the play-chapters-in-any-order feature seems limited for movies, but it may be attractive when DVDs with short subjects, like cartoons, come out.

John Shelton
Raleigh, N.C.

UNTIL MANUFACTURERS give us a format and a device to make copies as easily as we can now with a VCR, I see no reason to purchase DVD.

Robert L. Anderson
Albuquerque, N.M.

Weather Report

"WEATHER'S New Outlook" [Aug.] addresses the possibility of private weather companies taking over for the National Weather Service: Sure, and we don't need dairy farmers any more since you can get all the milk you need from the grocery store. Private companies do a good job of fine-tuning, marketing, and retailing weather information, but the weather service has a critical role in collecting, processing, archiving, and wholesaling weather data.

Vernon K. Jones
Charlotte, Miss.

YOUR INFORMATION about tracking hurricanes and tornadoes was a great companion while watching Weather Channel updates about Hurricane Danny.

Adam Newman
Roanoke, Va.

YOU MENTION a Gulfstream jet to study storms near the troposphere, which you say is six to 10 miles above the ground and contains most of the atmosphere's moisture. But the troposphere can be studied simply by walking outdoors—since it starts at sea level and goes all the way up the stratosphere, which begins six to 10 miles high, depend-

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ing on the latitude. I believe you meant to say tropopause, the boundary layer between the troposphere and the stratosphere. While the troposphere contains most of our atmosphere's moisture, the vast majority of that is in the lowest three to four miles, and most of our weather occurs below the tropopause.

Mike Alger

Chief Meteorologist, KTVN-TV
Reno, Nev.

Storm Shelter

"FROM THE Editor-in-Chief" [Aug.] says that a warning to take shelter was broadcast in Jarrell, Texas, 18 minutes before a tornado hit. Many took shelter in recommended areas—on the floor of centrally located closets or bathrooms. But they were still not totally safe: Builders in Texas use slab foundations with no underground storm bunkers. The improved warnings will be nice, but if you have nowhere to go for safety, what difference does it make?

cfranch@thezone.com
Austin, Texas

Contributions to the F-22

WHILE BOEING WAS mentioned, your piece on the F-22 ("Top Gun," June) did not identify the company as a key contributor in shaping this awesome fighter along with Lockheed Martin and Pratt & Whitney.

In addition to the life-support system mentioned in the story, Boeing is responsible for one-third of the F-22 program. Boeing's contribution includes the wings, the aft fuselage, the full-scale integration and test of the advanced avionics, 70 percent of the mission software development, the radar, the training system for pilots and maintenance personnel, the fire-protection system, and more.

Mike Tull

Boeing
Seattle, Wash.

Biosphere 2's Success

"SECOND CHANCE for Biosphere" [April] repeats many misconceptions and wrongly discredits those who built the facility. Biosphere 2 did not attempt to replicate Earth's ecological process. Instead, it was designed as a closed system where cyclic biospheric processes could be sustained, manipulated, and measured for long time periods—with the long-term goal of developing balanced systems. You trivialize Biosphere 2's significance by suggesting that its success is measured in tourist dollars.

William F. Dempster
Former Director of Systems
Engineering, Biosphere 2

In Hot Water

THE ILLUSTRATION in "Gain from the Drain" left me perplexed [Home Technology Newsfront, Aug.]. It shows cold water wrapping around the drain pipe, being heated, and proceeding to the shower where it mixes with the hot water.

Wouldn't this system work more efficiently if the warmed water supplied the hot water heater? The accompanying illustration also shows hot water supplying the shower coming from two different sources, which could lead to scalding.

Mark Goldsmith
scubnski@aol.com

The GFX system can be placed in several locations, one of which can be located to preheat cold water before it enters the hot water heater. Also, the GFX system only warms the cold water 30°F to 40°F. After the shower has run for a little while, an equilibrium is reached that prevents scalding.

Corrections: Nitrogen has a boiling point of minus 195.8°C, not minus 201°C as stated in FYI [July].

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125 YEARS OF POPULAR SCIENCE

EDITED BY MARIETTE DICHRESTINA & GUNJAN SINHA

Electronics Audio, video, and communications gear energize the modern era.

1927 The Looking Box

A YEAR AFTER THE FIRST TV was created by Scotsman John Loggie Baird, **POPULAR SCIENCE** in September 1928 conjectured: "Someday, perhaps in the not-so-distant future, we may have a television receiver that will do for your eyes what the broadcast receiver does so well for your ears." And how! In subsequent decades, we noted the advent of color, portable TVs, hang-on-the-wall versions, home theater, and now, digital.



Catch Me Anywhere

FIRST COMMERCIALIZED IN 1949, the pager remained a fairly cumbersome and expensive device for decades. But today's pagers are tiny, featherweight, inexpensive—and able to do new tricks: In December 1995, we noted one of the latest: a pager called the Motorola Tango that receives messages and sends replies.



1949

Mr. Blank Is Not In

IN A JUNE 1931 story called "Robot Answers Phone And Takes Message," we suggested: "One of these days a telephone caller may get this answer: 'Mr. Blank is not in. If you care to repeat a message, Mr. Blank will receive it upon his return.'" Thus the answering machine, invented by William Schergens, was ushered in.

1931

1978

Cell Calls

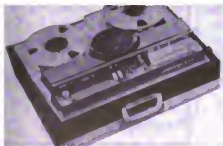
IN 1978, AT&T and Bell Labs began testing a phone like no other at the time: It would enable its users to reach out and touch someone from almost anywhere across the country. It was the cellular phone, and in 1981 the technology began to be available nationwide. The portability of cellphones has continued to advance as well. One tiny model, Motorola's 3.1-ounce StarTac, we hailed in December 1996 as "a gotta-have-it gadget."



1972

Watch It Later

"IS THIS THE YEAR you mate a home TV tape recorder to your TV set?" asked **POPULAR SCIENCE** in January 1965. Early VCRs recorded 45 minutes to an hour on thick reels of tape housed in a cabinet the size of a small refrigerator. VCRs began being sold commercially by 1972.





1902

Getting the Fax

THE FACSIMILE MACHINE was first conceived in 1902. In December 1934, *POPULAR SCIENCE* applauded RCA-Victor Co., which had "perfected" a fax that reproduced a page with a message, map, or picture in 8 minutes. "Early commercial use of the system is seen," the magazine opined. Common use was to wait until the 1980s, however.

1898

Play It Again

BUILDING ON AN 1898 design for a magnetic tape recorder, German Fritz Pfleumer discovered that coating paper tape with a magnetizable powder can reproduce sound; later versions substituted plastic for the paper. By 1939, we reported a related U.S. invention by Bell Laboratories in a story titled "Magnets Make Sound Record on Steel Tape."



1926

Spinning Tunes

THE FIRST ELECTRIC jukebox, which supplanted poor-sounding windup versions invented in the early part of the century, was "a phonograph that plays for a full hour without attention!" exulted *POPULAR SCIENCE* in a June 1927 story. Called the "audiophone," the jukebox was invented a year earlier by J.P. Seeburg of Sweden and offered a choice of eight records.

1901

Meet the Wireless

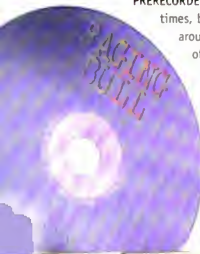
THOUGH GUGLIELMO MARCONI wasn't the first to send a wireless message, in 1901 he proved that communication over long distances is possible when he transmitted the first wireless message across the Atlantic by radio waves. Too early yet for voice, the message was in Morse code, *POPULAR SCIENCE* reported in February 1902.



1917

Circles for Sound

PRERECORDED AUDIO FORMATS have changed many times, but so often what goes around comes around: The cylindrical "records" (1877) of Thomas Edison's photograph evolved to analog long-playing records, or LPs, of vinyl (1947), which gave way to digital compact discs (introduced 1979). Now audiophiles can meet the latest: DVD, which holds 10 times the information contained on a CD, but still isn't recordable.



Also Noted...

- **October 1930** Electric typewriters ease that tap-tapping.
- **September 1948** Transistors for phones, TVs, and radios arrive.
- **June 1950** Electronic locks make for safer entries.
- **March 1972** Remotes encourage couch potatoes.

- **December 1984** Satellite dishes rain TV channels from heaven.
- **October 1996** Familiar rabbit ears come in new shapes.
- **September 1946** Tiny batteries power portable gadgets.
- **August 1964** Videophones: No more talking in your jammies?

The trouble with ordinary maps is, they don't know where **you** are.

this is no **ordinary** map.

Meet the GPS III—a Global Positioning System receiver with electronic map. It not only shows the lay of the land, but where you stand, too.

We've loaded millions of miles of interstates, highways, railroads, rivers and shorelines into the

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The GPS III's 12 parallel channel receiver will find

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The GPS III tracks your route and stores favorite spots with names, icons and a brief description. With one keystroke, trip odometer and speed calculations are in clear view. It will even display sunrise and sunset times so you're not left in the dark.

Where you're going.

Most remarkable about the GPS III is its basemap.

It shows primary landmarks for North, South and Central America. And after telling you how far you are from a given point, it will figure the time required to arrive.



Of course, only GARMIN offers the versatile flip-flop display. Vertically, it's a handheld for hiking. Push a button and

the display reads horizontally for installation on your boat, bike or car.

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WHAT'S NEW

EDITED BY SUZANNE KANTRA KIRSCHNER

Research by John Fredericks, Christopher Miller,
Sharon Parmet, Noah Rothbaum

Hyperdrive Camera

CANON'S OPTURA digital video camera operates in three modes: regular-video, still-photo, or progressive-scan movie. In progressive-scan movie, the camera takes 30 pictures per second for as long as 60 minutes. This is made possible by the camera's progressive-scan charge-coupled device, which captures 60 full fields per second. Regular CCDs record the even lines of the first picture, and then the odd lines to create a full frame. In still-photo mode, you can attach a regular flash. Price: \$2,499.



Tiny SUV

THE TINY BRITISH-ENGINEERED Gazelle sport-utility vehicle is powered by a Cosworth 2.9-liter V6 generating 215 horsepower. Other features include a rolled-aluminum body, five-speed automatic transmission, and full-time four-wheel drive. Available this winter for less than \$18,000. Eurasia Motor Corp., 1500 Cordova Rd., 2nd FL., Fort Lauderdale FL 33316.



DVD Player with Zoom

TOSHIBA'S SECOND-GENERATION DVD player adds a new wrinkle: 4X zoom. The new top-of-the-line model, listing for \$799, allows you to enlarge 25 different points on the screen for closer examination, even in slow motion. Another new feature is video black-level expander circuitry, which lets you increase the contrast in the picture for deeper blacks. Toshiba America Consumer Products, 82 Totowa Rd., Wayne NJ 07470. www.toshiba.com



Hideable Keyboard

SWING FORWARD the keyboard of Fujitsu's Intertop mobile PC for a compact subnotebook. Or tuck it underneath the unit's 7.2-inch touchscreen LCD for pen input. Folded up, it is approximately 8½ by 6 by 1¼ inches and weighs only 1.7 pounds. One drawback: Its proprietary operating system is not compatible with Microsoft Windows, making transfer of data to your PC difficult. On sale in Japan for about \$1,100; overseas sales are planned.

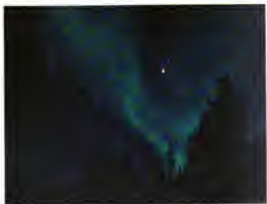


Digital Pen

THE PROTOTYPE Digital Ink pen, developed by Engineering Design Research Center at Carnegie Mellon in Pittsburgh, recognizes and stores handwriting and drawings. After completing a memo or drawing on any flat surface, write "send" or "e-mail" followed by a fax number or e-mail address and the document is sent wirelessly. The digital "ink well" lets you download stored information to a desktop computer or another digital pen.

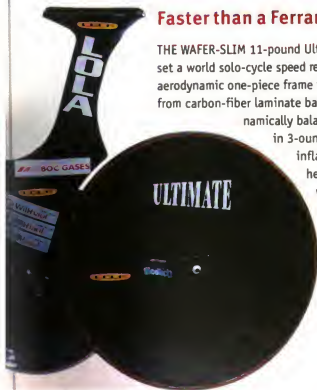
Sky Theater

FOUR ELECTROHOME video projectors, surround sound, and laser lights combine to bring the Aurora Borealis and other celestial events to life at the Watson Lake Northern Lights Centre in Canada's Yukon Territory. The ElectricSky Theater also features a star-projection system that's capable of projecting the images of 2,354 stars, 88 constellations, and 57 navigation stars.



Faster than a Ferrari

THE WAFER-SLIM 11-pound Ultimate Bike has set a world solo-cycle speed record of 207.9 mph. Its aerodynamic one-piece frame is ultrarigid, fabricated from carbon-fiber laminate baked for strength. Dynamically balanced disc wheels shod in 3-ounce silk/Kevlar tires are inflated to 250 psi with helium gas to provide weight-countering lift. Prices start at \$15,000. The Ultimate Bike Project, 34 Colin McLean Rd., East Dereham, Norfolk NR19 2RY England.



Force feedback adds the sense of touch to supported games so you can actually feel the game. But a force feedback joystick isn't worth a dusty Pong if the stick is pulling processing power from your computer and slowing down your game. That's why the Microsoft® SideWinder® Force Feedback Pro has a **25MHz 16-bit "force co-processor"** that does all the force computation on the stick. Which means your computer feels nothing, and your games are never slowed down. Force Feedback Pro is as much as six times faster than other force sticks. So you'll

The stick is also **easily customizable**, so in just a few seconds you can program each

button the way

you like to play.

And forget port

hogging. Force

Feedback Pro has only one computer cable and plugs into your gameport.

Plus, you can test all these features right away with the **three killer games included in the box:** Interstate '76™, Star

Wars® Shadows of the Empire™

Battle of Hoth™, and

You'll feel it. Your computer won't.

see and feel every
Uzi recoil, every
stall on take-off
from O'Hare,
and every nine-
iron you shank to
the left.

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rocket-science stuff inside
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handle and throttle motion to within one-
hundredth of a degree without any
wear or calibration.



MDK: Mission
Laguna Beach™

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SideWinder Force

Feedback Pro. It's

designed so that
everything in your game

will be felt. But only by you.

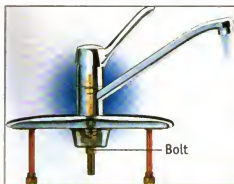
For more information (yes,
believe it or not, there is more), go to

www.microsoft.com/sidewinder

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One-Bolt Simplicity

MOEN'S SINGLE-HANDLED faucets ease installation with a single-bolt tie-down: When the bolt is tightened, the slightly bowed deck pulls down, creating a watertight seal. The faucets also include a concealed self-sealing gasket, so no plumber's putty is needed. Price range: \$85 to \$275. Moen Inc., 25300 Al Moen Dr., North Olmsted OH 44070.

Internet Boy?

GAME.COM, A NEW handheld video-game console, can connect to the Internet via an optional Internet cartridge and modem. It's similar in size to Nintendo's Game Boy and features a 3 1/4-inch black-and-white touch-sensitive LCD. The unit comes with a built-in organizer; games are stored on tiny cartridges. Price: \$70; Internet cartridge, \$20. Tiger Electronics, 980 Woodlands Pkwy., Vernon Hills IL 60061.



Smooth Rider

SPORTING A CAST-ALUMINUM chassis and a new Telever front suspension that handles road bumps with aplomb, BMW's K1200RS sport-touring motorcycle is surprisingly nimble, given its 600-pound bulk. A 1,171cc liquid-cooled 16-valve inline four-cylinder engine delivers 130 horsepower, with smooth shifting courtesy of the company's first six-speed gearbox. Other features include BMW's Anti-Lock II brakes, which reduce front-end dives during rapid stops, and optional heated handgrips. Price: \$16,000. www.bmwusa.com

Easy-Charge Mower

BATTERIES TO power the electric starter on mowers are traditionally located under the mower deck, requiring that you bring the whole mower to the outlet for recharging. Murray has relocated the battery pack on its 20705X92 model to the handle for quick removal and charging. Price: \$317.



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Piggyback Antenna for Satellite TV

SATELLITE-TV OWNERS know that receiving local broadcasting stations requires an indoor or rooftop antenna. Now you can attach the Emerson Dishmate antenna to the back of your satellite dish using existing bolts. Because the antenna is omnidirectional, it doesn't interfere with dish alignment. For fine-tuning, you position a special 8-foot section of feed cable that connects to Dishmate. Jasco Products Co., 311 N.W. 122nd St., Oklahoma City OK 73114.



Massage Tub

IF IT ISN'T THE ULTIMATE water massage, the Kohler Vigora whirlpool tub may come close: Three sets of jets line the backrest, four are spread across the bather's

shoulders, and two, concealed in a Lycra-covered pillow, pulsate in sequence to simulate the feel of a hand massage. Two more jets are positioned at the bather's feet. Prices start at \$6,100, not including faucets. www.kohlerco.com



Light on Demand

POLAROID'S PolaPulse flashlight is slightly larger than a credit card and as flat as a pancake. A proprietary 6-volt zinc manganese dioxide battery delivers pulses of power for a brighter light, and lasts for five years. The \$7 water-resistant light has a hole at the rear that lets you attach it to a keychain.



Beyond Snowboards

THE SLOPES WILL SEE a new board this winter: the Sno-Go. It features a steering column, foot-pedal brakes, and even an emergency brake for quick stops. Riders stand upright with feet parallel to the board, not angled as with conventional snowboards. Prices range from \$300 to \$700, depending on the size and construction—fiberglass or graphite. Sno-Go, 4841 N. Scottsdale Rd., Suite 103, Scottsdale AZ 85251.



Spikes worn by Bob Mathias in 1952, the day he broke the World Decathlon record in Helsinki, breaking a record he had set two years earlier.



The new Ironman Triathlon analog digital combo

Watch worn by Mark Chesney the day he finally made it to the top of Devil's Hill on his bike, beating his black Lab, Boomer, in the process.



The new Ironman Triathlon watch with Data Link



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Steady as She Goes

THE CUTTERHEAD-SNIPE lock (shown in inset) on Delta's 12 1/2-inch Portable Planer locks the cutting blade into place for smooth and even planing. The \$572 tool can handle stock 12 1/2 by 6 inches with a maximum depth cut of 1/4 inches. Delta International Machinery, 246 Alpha Dr., Pittsburgh PA 15238. www.deltawoodworking.com/delta

House Finder

THE ELECTROLUMINESCENT Address Light glows a cool lime green to illuminate your street number, so guests or emergency-response teams can find your house easily at night. The \$40 120-volt light uses less than a dollar's worth of electricity per year. The Address Light comes with four letters or numbers. Austin Innovations, 2222 W. Rundberg La., Suite 400, Austin TX 78758.



Video CD-ROM

DETAILED BACKGROUND imagery makes the Nightmare Ned CD-ROM of horrors especially chilling. It's the first to use full-motion video-streaming technology, which enables the developer to create more lifelike 3-D worlds. Price: \$40. Disney Interactive, 500 S. Buena Vista St., Burbank CA 91521.

Multimedia TV

THE HITACHI MMV is the first computer-grade—640 by 480 resolution—display to incorporate a TV tuner. The 27-inch unit has S-Video as well as RCA jacks and a VGA port. Price: \$800. Hitachi Home Electronics, 3890 Steve Reynolds Blvd., Norcross GA 30093.





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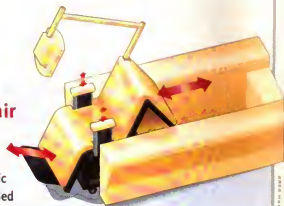
Traversing Trimmer

FLOATING ON A CUSHION of air, Husqvarna's hovering trimmers help tackle sloped lawns, lake banks, and other difficult terrain. The cordless trimmers are powered by a two-cycle engine and produce an even grass height of as much as 2 inches. The price varies according to the cutting width: HVT1200 (12 inches) \$370, HVT1500 (15 inches) \$420, HVT2000 (21 inches) \$550. Husqvarna Forest & Garden, 9006 Perimeter Woods Dr., Charlotte NC 28216. www.husqvarna.com



Convertible Chair

A PROTOTYPE wheelchair/bed called the Reconfigurable Holonomic Omnidirectional Mobile Bed (Rhombus) eases the shift from chair to bed. The wheelchair portion docks into a horseshoe-shaped frame and reclines to form a twin bed. The chair is controlled by joystick or remotely via the unit's onboard computer, and features a teleconferencing system. MIT, Room 5-111, 77 Massachusetts Ave., Cambridge MA 02139-4307.



Colorful Car Stereo

PANASONIC'S CQ-VX777 car stereo appeals to the eye as well as to the ear. Its large display uses four colors to show the graphic equalizer settings. And a second window reveals the operating status of the radio, CD, and cassette. Price: \$1,000.



Videoconferencing to Go

NO MORE DOCKING stations and card installations for videoconferencing on the go: Just plug the VideumCam Traveler camera into a PC Card slot and you're ready to go. Winnov packs a video and audio capture board into the camera for full-motion video. A desktop kit is also available. Price: \$299. Winnov, 1150 Kifer Rd., Suite 201, Sunnyvale CA 94086.





Virtual Smells

DO YOU LONG for the suntan lotion and saltwater smells of the beach, or maybe the burning rubber and motor oil smells of the track? Virtual Scentsations virtual reality kiosks offer audio, visual, and olfactory stimulation via a head-mounted stereoscopic 3-D display, surround sound, and smells as part of three games. Digital Tech Frontier, 6700 West Chicago, Suite 1, Chandler AZ 85226.



Playful Grizzly

YAMAHA'S GRIZZLY 600 4X4 all-terrain vehicle can work hard—and play hard. Its 600cc engine is the most powerful offered by a four-wheel drive ATV. And the Ultramatic transmission uses both a centrifugal and sprag (one-way) clutch. While downshifting, the centrifugal clutch is released, but the sprag clutch continues transmitting braking force for improved engine braking. Grizzly has on-command four-wheel drive and adjustable rear suspension. Price: \$6,499.



In Elliptical Motion

OFFERING IMPACTLESS exercise, elliptical-motion machines blend the movement of a stair climber, treadmill, and bike. NordicTrack is now offering its Ellipse models for home users. The e7 (shown) and e9 also have cross-country ski "poles," so you can exercise all major muscle groups. The e5 comes without the poles. Price: \$599 to \$899. NordicTrack, 104 Peavey Rd., Chaska MN 55318.



Great Graphics

RIVEN, THE LONG-AWAITED sequel to Myst, raises the bar for computer-game graphics. Riven's beautiful, highly detailed 3-D world comes alive with touches like rippling water, random animal appearances, and eerie music. The Windows CD costs approximately \$50. Reb Orb Entertainment, Box 6121, Novato CA 94948.



Dry Diving

YOU DON'T NEED any scuba experience—or even a swimsuit—to dive to 50 feet underwater in the SeaMobile submersible. A supervising diver pilots the 14-foot-long sub, but in suitable conditions, he can allow the two passengers seated inside the pressurized compartment to take control with a joystick. The sub is intended for resorts, where a half-hour tour would probably cost \$50 per person. SeaMagine Hydrospace Corp., 976 W. Foothill Blvd., Suite 215, Claremont CA 91711. www.seamagine.com

Corolla Overhaul

THE ALL-NEW 1998 TOYOTA Corolla is more powerful, safer, and more fuel efficient. It delivers 15 more horsepower, with its all-aluminum 120-hp 1.8-liter dual overhead cam inline four-cylinder engine. Fuel economy is also upped by 10 percent—31 miles per gallon city/38 highway. Side airbags are optional. Prices start at approximately \$13,000.



Manual or Automatic

SWITCH FROM AUTOFOCUS to manual on the fly with Sigma's APO Tele Macro 300mm f4.0 lens. Press the shutter release partway, and you can manually turn the focus ring. After you shoot, the lens returns to autofocus mode automatically. The hypersonic autofocus motor is the quietest and smoothest available. Compatible only with Canon EOS and Sigma AF 35mm cameras. Price: \$1,164. Sigma Corp., 15 Fleetwood Ct., Ronkonkoma NY 11779.

The Organized Phone

SHARP'S PERSONAL Mobile Communicator combines a digital cellular phone and an electronic organizer. The communicator includes e-mail and synchronization of schedule and address-book information with a PC. A product is due on the European market this fall; no plans have yet been made for North America.



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SONY

No-Sweat Stapler

WITH SWINGLINE'S Desktop High Capacity Stapler, you can staple together as many as 60 documents as easily as you can two. Swingline moved the stapler's center of gravity from the end to the middle, thus increasing leverage. Price: \$35, including a package of 500 staples. Acco USA, 770 S. Acco Plaza, Wheeling IL 60090.



Lighting Up Rover

FOR WALKING YOUR DOG at night, Black & Decker combines a 16-foot retractable dog leash with a built-in flashlight. The \$40 leash is strong enough for dogs as heavy as 80 pounds. The light runs for 2½ hours on two C alkaline batteries. www.blackanddecker.com



Low-Cost Computer

THE GEOBOOK NOTEBOOK computer costs only \$600. The 4.2-pounder features a 9.4-inch monochrome VGA display and built-in 14.4Kbps modem. It runs on the Geos operating system and is preloaded with an Internet browser, personal information manager, spreadsheet, and word processor. You can save files in a Windows-compatible format. Brother International, 200 Cottontail La., Somerset NJ 08875.



Mobile Meetings

THE MSV 1120S MINI-BUS is equipped for multimedia presentations with a 20-inch TV, VCR, and audio system. The 6-foot 5-inch mobile conference room seats as many as 16 people. Gull-wing doors enable easy entry and four-wheel independent steering gives the vehicle car-like handling. Mauck Special Vehicles, 3736 Paragon Dr., Columbus OH 43228.



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NEWSFRONTS

SCIENCE & TECHNOLOGY

EDITED BY DAWN STOVER

SPACE

Which Way Is Up?

ONE OF the tenets of modern cosmology is that the universe is isotropic—it has the same properties in all directions. But recently, two physicists published results that stand this belief on its head.

Borge Nodland of the University of Rochester and John P. Ralston of the University of Kansas claim that the universe has an axis that is pointed toward the constellation Sextans. The claim is based on observations of radio waves emitted by 160 galaxies. Such radiation is polarized, or rotated, as it travels toward Earth. If the universe is isotropic, the degree of polarization should be the same no matter where the galaxy is located. But



The red line running between the constellations Aquila and Sextans, with Earth at its center, represents an axis in space. The polarization of radio waves emitted by galaxies close to the axis (such as Galaxy A) rotates more than the polarization of radio waves farther from the axis (such as Galaxy B).

Nodland and Ralston found that radio waves from galaxies lying along the putative axis show significantly greater polarization. "This work defies the notion that there is no 'up' or 'down' in space," says Nodland.

No branch of science is more contentious than cosmology, and

a riposte came quickly from two other experts, Daniel J. Eisenstein of the Institute for Advanced Study in Princeton, New Jersey, and Emory P. Bunn of Bates College in Lewiston, Maine. They have found a statistical error in the original calculations, they say—a claim vigorously denied by Nodland and Ralston.

Meanwhile, two Stanford University electrical engineers have proposed an explanation that restores the classic view of the cosmos yet accounts for the observed differences in polarization. Ronald N. Bracewell and

Von R. Eshleman believe the sun's cosmological motion is responsible. The sun appears to be traveling at about 300 kilometers a second relative to the universe as a whole. This motion creates an axis that points in about the same direction as that reported by Nodland and Ralston, and Bracewell and Eshleman say it could produce the same kind of variations, although the mechanism for doing so is unclear.—Arthur Fisher

CHEMISTRY

Slip Sliding Away

FROM POWER TOOLS TO CARS, a variety of machines could last longer and run more efficiently with the help of a new lubricant. It's made from molecules that act like tiny ball bearings.

To reduce friction, conventional high-performance lubricants contain such solid ingredients as tungsten disulfide, which has platelet-shaped molecules. Over time, however, the edges of the platelets can abrade machine parts.

Reshef Tenne of the Weizmann Institute of Science in Rehovot, Israel, leads a team that can make tungsten disulfide form buckyball-like spheres. "We cook metal oxides and sulfur to 800°C," he says. The compounds curl into spheres 1,000 angstroms in diameter. The spheres cut the friction level attained by conventional lubricants in half and reduce wear on parts to one-sixth of current levels, says Tenne.

Next, Tenne will work toward manufacturing the tiny spheres on a commercial scale.—Mariette DiChristina

PSYCHOLOGY

Imagination Inflation

HOW MALLEABLE IS MEMORY? According to the latest research, it can be surprisingly easy for the brain to create recollections of things that never happened. The findings have important implications for courtroom testimony and psychological counseling.

In one recent study at the University of Washington, psychology professor Elizabeth Loftus gave subjects a list of 40 possible childhood events—such as falling and putting a hand through a window, getting in trouble for calling 911, or finding a \$10 bill in a parking lot. The subjects were asked to rate the likelihood that these events had happened to them.

Two weeks later, the subjects were asked to imagine some of the events that they said had not happened. For

example, some subjects were told to imagine themselves playing in the house after school, hearing a strange noise outside, and then tripping and breaking a window with their hand as they ran to see what was making the noise. After this imagination exercise, which lasted only a minute, the subjects were asked a second time about whether the event had really happened; 24 percent rated it as more likely than they previously had.

"One simple act of imagining a fictitious childhood event increased people's confidence that the event happened to them," says Loftus, who calls the phenomenon "imagination inflation." She says the act of imagination may have reminded people of a real experience, but that a more likely explanation is that the act of imagination simply created feelings of familiarity that were mistaken for actual memories.—D.S.

ENGINEERING

The Future of LEDs:
Color-Making Plastics

THE SHELLS of today's televisions, computers, and other household products are commonly made from plastic. But tomorrow's products may elevate plastic to a more important role. A team of chemical engineers and physicists from the University of Rochester and Xerox Corp. has developed plastic light-emitting diodes, or LEDs, which may be used to create wall television screens;

displays for personal computers and other devices.

LEDs, which convert electricity to light, are already familiar as the providers of illumination for the digital displays of alarm clocks, automobile instrument panels, fax machines, and a host of other products. But conventional LEDs, which are made from such materials as gallium arsenide, cannot emit light of multiple colors.

The plastic LEDs, however, can produce a variety of colors, including

MEDICINE

Ring Monitor

WHAT'S SMALL, lightweight, and so innocuous that you wouldn't mind wearing it 24 hours a day, especially if it could save your life? It's a ring developed by MIT researchers to monitor a patient's vital signs.

H. Harry Asada and Dr. Boo-Ho Yang designed the ring for elderly people and others at medical risk.



New plastic light-emitting light of more than one color



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THE HUMAN BODY

A Matter of Taste

GEORGE BUSH hates broccoli. So do lots of Americans, and their repugnance extends to other vegetables like brussels sprouts and to fruits like grapefruit. Why some people and not others?

Such preferences, researchers reported at a meeting of the American Association for the Advancement of Science earlier this year, turn out to be genetically determined. Some of us inherit the dominant form of a gene that governs sensitivity to bitterness and other flavors. Such people are "supertasters," who recoil at eating cabbage-family vegetables and some

citrus fruits and berries, all of which contain bitter-tasting compounds called flavonoids.

The rest of us are divided into regular tasters and nontasters. Non-

tasters have a recessive form of the gene and are insensitive to bitterness and sweetness. They tend to eat everything but the kitchen sink.

Taste differences could have important health ramifications. The flavonoids and other ingredients that supertasters find unpalatable

Do you avoid eating berries? If so, maybe you have the genes of a supertaster.

are exactly those believed to help prevent many kinds of cancer. Thirty-five percent of Caucasian women are supertasters. "One of the questions we're asking is: Do women with breast cancer avoid these foods?" said Adam Drewnowski, who is director of the Human Nutrition Program at the University of Michigan School of Public Health. The study is not finished, but Drewnowski believes a link exists between breast cancer and supertasters.

But nothing about human behavior and health is that simple. If female supertasters are at greater risk for breast cancer, their taste buds may give them extra protection against diabetes and heart disease. Why is that? Lauri Ann Lucchina of the Yale University School of Medicine reported that studies of middle-age and elderly supertaster women show that they avoid high-fat milk products and sweets, and tend to be slimmer and have higher blood levels of "good" cholesterol than other women.—A.F.



People who hate broccoli may have super-sensitive taste buds.

ASTRONOMY

Distant Planet

CAN YOU NAME a planet beyond Pluto in our solar system? If you said 1996TL₆₆, take a bow. The tiny—a mere 300 miles in diameter—planet was recently discovered by astronomers at the Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts; the University of Hawaii in Honolulu;

and the University of Arizona in Tucson. An amateur astronomer also shared in the discovery.

Orbiting in an oblong path as much as three times as far from the sun as Pluto, the little planet is too minor to merit the name of a Roman god. 1996TL₆₆ is thought to be part of the Kuiper Belt, a collection of icy bodies at the edge of the solar system.—M.D.

THE OCEANS

Fish Saver

MILLIONS FEWER dying fish will be tossed overboard if fishermen trawling for pollock in the North Pacific adopt a new type of net.

The \$6 billion walleye pollock fishery is the nation's largest. But full-size pollock aren't the only creatures caught in pollock nets. Young pollock, other fish, crabs, and other marine animals—collectively known as bycatch—account for as much as 10 percent of the total catch. Starting next year, all bycatch must be brought into port, according to the North Pacific Fishery Management Council, a regulatory agency based in Anchorage, Alaska.

"If the ships are filled with bycatch, there's less room for the more valuable adult pollock," says Ellen Pikitch, director of fisheries programs at the New York-based Wildlife Conservation Society. That gives fishermen an incentive to use a new net that Pikitch helped develop. In tests, it reduced bycatch by up to 75 percent.

Pikitch took traditional diamond mesh netting—which closes when dragged through the water—and rotated the openings to form squares that stay open when dragged. Instead of double layers, the top of the new net has only one, which helps small fish escape.

Several ships are already using the net. Pikitch expects more to adopt it once the new rules go into effect.—Richard A. Marini



The top half of this net has a new design that allows small fish to escape.

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AGRICULTURE

Tree Bombs

MOSHE ALAMARO wants to launch the most extensive aerial bombing campaign ever waged. But he's trying to save the planet rather than destroy it.

The MIT doctoral student in mechanical engineering proposes to reforest inaccessible areas by "bombing" them with cone-shaped biodegradable canisters containing tree seedlings, water, and nutrients. A single aircraft could plant as many as 100,000 trees in one flight, according to Alamaro. The first test of the concept is planned



Tree seedling



Dropped from an airplane like bombs, seedlings in cone-shaped containers would bury themselves in the ground.

for later this year at an Army base in New England.

More work is still needed to develop container materials that are sturdy enough to survive the impact of an airdrop but degrade quickly enough to enable a sapling to take root. Alamaro is also trying to figure out the best nutrients to put in the payload, and the density of the packet that would ensure optimal penetration of the seedlings into the soil.

While the idea has attracted interest from government officials and companies in nearly a dozen countries, including the United States, Alamaro so far lacks the financial backing that's needed to move the project forward. Regarding a possible source of aircraft, he points to a fleet of thousands of idle military planes now parked in an Arizona desert. "I have a big mission for them," he says.—Steve Nadis

HUMAN EVOLUTION

Distant Relations

ARE WE THE descendants of Neanderthals? Genetics testing by a team of U.S. and German researchers shows that the heavy-browed hominids merit their own branch on the family tree, separate from humans.

"Neanderthals are not our ancestors," declares team member Mark Stoneking, an anthropologist at Pennsylvania State University. Neanderthals, who died out some 30,000 years ago, coexisted with humans in Europe for perhaps 20,000 years but did not interbreed.

The researchers compared mitochondrial DNA extracted from 30,000-year-old Neanderthal bone with that from modern humans living on five continents. Found in the energy-producing parts of cells, mitochondrial DNA is easier to recover than DNA from a cell nucleus.

The researchers sequenced 378 base pairs, or chemical building blocks, of the Neanderthal DNA. Neanderthals had a greater range of differences than the human norm. "In this particular region of DNA, humans usually have seven or eight differences among the base pairs," says Stoneking. "The Neanderthals averaged about 27 or 28."

The researchers infer that Neanderthals and humans diverged 500,000 to 600,000 years ago—making the Neanderthal lineage four times as old as that of humans.

Although Neanderthals may not share direct lineage with humans, they had at least one strikingly human pastime: music. Ivan Turk, a paleontologist at the Slovenian Academy of Sciences in Ljubljana, Slovakia recently found a 43,000-year-old piece of a bone flute at a Neanderthal campsite. Analyzed by Canadian musicologist Bob Fink, the flute once sounded notes that would've been familiar to our human ears: do, re, mi, and fa.—M.D.

CHEMISTRY

Edible Immunity

GETTING A vaccination could soon be as simple as eating a potato. Researchers at the University of Maryland, led by Dr. Carol Tacket, are developing edible vaccines that could grant immunity against some diseases.

To be inoculated against a virus, bacterium, or toxin, the antibodies of our immune systems must be exposed to the illness-bearing agent, or pathogen. Vaccines work by exposing the body to pathogens that have been killed or disarmed. Once sensitized, antibodies can mobilize rapidly against familiar enemies by binding to them and preventing their growth and activity.

Most vaccines are delivered in shots or pills, but the new one will be incorporated in raw potatoes. The potatoes have been genetically engineered to produce the key piece of an

E. coli toxin that causes acute diarrhea. As the spuds move through the intestinal system and are digested, the toxin fragment is released and exposed to the immune system, which then generates antibodies against the toxin.

Dr. Tacket's group is waiting for approval from the FDA to test the potato vaccine on humans; it has already been tested successfully in mice. The next step would be to genetically modify bananas to carry vaccines, because raw bananas taste better than raw potatoes.

The potential for edible vaccines is tremendous, especially in developing countries. Whereas current vaccines are expensive to produce, store, transport, and administer, an edible vaccine could be grown where it is needed in the quantity desired, and requires considerably less medical expertise to use.—K.W.

"We were about nip and tuck at the end of the first mile. Then I heard a quiet hum. He went by so fast that we could not even get in his draft."

—A competitive rider, on his first look at a racing Harley, 1913.

to the parking lot. Then there you are, face-to-face with your ride home. The last, unrestricted echo of a race-tuned exhaust still dying in your ears.

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ELECTRONICS

EDITED BY FRANK VIZARD

ELECTRICITY

Is the TV Turned Off?
Not Exactly

YOUR STEREO AND television are leaking, but don't call a plumber: This is an electrical problem. In increasing numbers, electronic devices continue drawing power to maintain standby mode even though they are switched off. Scientists at the Lawrence Berkeley National Laboratory in Berkeley, California, estimate that 5 billion watts, equivalent to the energy generated by five average-size power plants, are lost to "leaky" appliances every year.

By definition, a leaky appliance is one that consumes energy when it is switched off or not performing its principal function, says Alan Meier, a Berkeley scientist. In standby mode, the average TV and VCR draw close to 16 watts, and a cable box alone siphons

off 20. Stereos, cordless phones, mini-vacuums, and answering machines also leak energy. But they are not the worst energy offenders.

"Low-voltage transformers are notorious," says Steve Greenberg, a Berkeley scientist. "Those little black cubes consume 1 watt each when they're not in use," he adds. Cheap versions, nicknamed "vampires," draw 3 watts. Meier estimates that half a billion little black cubes are currently plugged into electrical outlets.

The average home leaks a total of about 50 watts, some \$4.20 a month, estimates the laboratory. To stem leaks when electronic devices are not in use, "Plug your appliances into a power strip and turn it off. Install outlets with a switch. Or, simply unplug your appliances," Greenberg suggests.—Christopher Miller

How much electricity does your appliance waste?

Cordless phone

2 watts per hour

Portable stereo/Boom box

3

Video game machines

5

Answering machine

5

TV

6

VCR

10

Compact audio system

10

Cable box

20

Typical rates of leaking electricity from some common appliances.
The average U.S. home leaks 50 watts.



VIDEO

Wires for a Better Picture

MOST VIDEO FANATICS are familiar with the composite and S-Video connectors used to link VCRs and TVs. Of the two, S-Video offers a higher-quality picture. However, new TVs and other video equipment from Sony, Toshiba, and other companies are using a new connector called component video to create the best picture yet.

A component video connector carries the video signal as three separate elements: one luminance channel for black-and-white information and two chrominance channels for color. With this setup, the signal is unaffected by the modulation that normally occurs, bypassing the NTSC decoder and comb filter in the process. This means that picture artifacts like dot crawl, color noise, cross-color interference, and moiré patterns are largely avoided. The result is a picture with purer color and better resolution.

Not surprisingly, component video connectors are appearing first on more expensive gear but will gradually become more widely available. They are also destined to be a feature on future digital TVs.

In the meantime, if you want to convert your composite video signal to S-Video to make the link between a VCR and receiver, try a new \$100 connector called the Tribute C2S converter by Tributaries, a division of Gordon J. Gow Technologies Inc. in Orlando, Florida (800-521-1596). By passing the signal through a series of ceramic and inductive filters, the connector can achieve frequency separation between the chrominance and luminance information, says the company.—F.V.



SECURITY

Eye Scans for ATMs

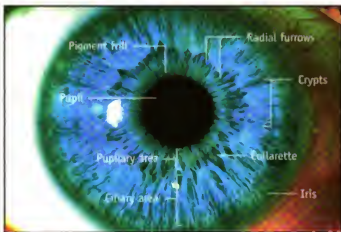
YOU SOON MAY be able to get money from a bank's automated teller machine simply by looking at it. Starting this fall, Sensor Inc., of Moorestown, New Jersey, is teaming up with London-based ATM-maker NCR Corp. to install the IrisIdent iris-recognition system into ATMs around the world. IrisIdent digitally encodes pictures of the iris, the colored part of the human eye, to provide a highly accurate, virtually fraud-proof means of

identification—making PINs obsolete. The unique pattern of lines in each iris makes an even more reliable identifier than a fingerprint.

Customers give their "iris signature" at the bank, where an IrisIdent camera scans their iris from about 3 feet away. The iris image is then digitally encoded and kept on file.

At the ATM, you insert your bank card. Then, a camera in the ATM focuses on your eye, zooms in on the iris, and takes a picture. IrisIdent then compares the image of your iris with those in its database. If your iris matches the image associated with your card, the machine will allow a transaction. The whole process takes only

about 3 seconds. For banks with ATMs capable of dispensing airline tickets and stocks and bonds, IrisIdent will give them the security they need to deliver these documents without the fear of fraud. Because each iris is unique, the cards will eventually be phased out, since the machine can accurately distinguish an individual by the iris alone.—Sharon Parmet



IrisIdent takes advantage of the fact that every eye is different, using over 200 different markings to make an identification. Key indicators are shown here.

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ANTENNAS

Odd Shapes for TV

THINK ABOUT television antennas, and images of rooftop aerials and rabbit ears come to mind. Some new antennas, however, are challenging preconceived notions. Terk Technologies, a Commack, New York, company that specializes in antenna design, now offers the TV50, a 73-inch-long bar designed to be mounted horizontally on either an inside or outside wall. The configuration of the antenna makes it particularly effective in receiving low-band VHF signals (typically channels 2 through 5), says Terk. The TV50, \$130, also includes an amplifier that lets it receive signals from as far as 60 miles away, according to the company. The amplifier can be switched on and off. Connectors are weatherproof, and a kit included in the package enables you to connect a DSS satellite TV cable so only one wire enters the home.

Emerson's Optima TV4750, meanwhile, is a flat rectangle measuring 15 by 13 inches and 2 inches deep. But the key to its performance is the 8-foot cable to which it is attached. You fine-tune the signal reception by adjusting the height of the cable, which must be laid in a horizontal position. This cable is then connected to another coaxial cable running to the TV. The \$80 Optima TV4750 has an effective range of about 20 miles, says the company, but this range can be increased with the addition of an amplifier.

Our evaluation showed Terk's TV50 to be the more effectively designed solution. The 8-foot cable used with the Emerson antenna tends to move, damaging picture quality. The Terk TV50 provided clearer reception during our tests. Keep in mind that antenna performance does tend to vary tremendously from location to location, however.—F.V.

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HOME TECHNOLOGY

EDITED BY WILLIAM G. PHILLIPS

COOLING

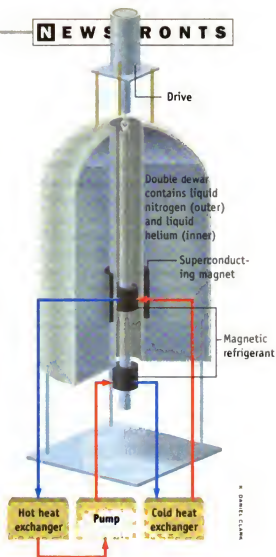
An Attractive Idea

KARL GSCHNEIDNER has a vision: Ten years from now, he sees energy-efficient refrigerators and cooling systems that don't use ozone-eating chlorofluorocarbons (CFCs) or their gaseous replacements for refrigerants. Instead, Gschneidner, a materials scientist at Ames Laboratory in Iowa, envisions systems that use magnets as the refrigerant—and they'll be up to one-third more efficient than today's vapor-compression machines.

Conventional machines use a compressed gas as the refrigerant, which conveys heat to create cooling. But magnetic cooling, being developed by Gschneidner and his colleagues at Ames Lab with partner Astronautics Corp. of America of Madison, Wisconsin, will take advantage of the magnetocaloric effect. That's a property of certain materials that heat up when magnetized and cool when demagnetized.

In an experimental version of the system tested for six months, gadolinium spheres were used to demonstrate the technology. At the same time, Gschneidner and his colleagues discovered gadolinium-silicon-germanium alloy, a new material that doubled the performance of gadolinium, previously the best-known magnetic refrigerant. While the alloy costs slightly more than gadolinium, says Gschneidner, it improves efficiency by 25 percent—enabling magnetic cooling to significantly outperform conventional vapor-compression systems. The alloy can be "tuned" for different operating temperatures—a higher temperature for an air conditioner, a lower one for a freezer, for instance—by adjusting the ratio of silicon to germanium. The more germanium used, the lower the temperature.

Gschneidner hopes to adapt the system for heating as well as cooling. "There's even more energy-saving potential with heat pumps," he adds.—*Mariette DiChristina*



An experimental refrigerator uses a special material, called a magnetic refrigerant, which slides up and down inside a superconducting magnet. When the material is magnetized, it's hot; demagnetized, it cools. The cooling is conveyed to a heat exchanger by a water-antifreeze mixture.

SAFETY

The Light Stuff

INEXPENSIVE, A GREAT light source—and potentially deadly. That's the ubiquitous and controversial halogen torchiere, which the U.S. Consumer Product Safety Commission has blamed for 100 fires and

10 deaths since 1992, including the blazes that devastated England's royal Windsor

But researchers at the Department of Energy's Berkeley National Laboratory are cooling the controversy with a new lamp that burns at 100°F. The lamp houses two 36-watt compact fluorescent lamps that generate 50 percent more light but use one-quarter the energy of halogen models. That translates to \$136 in energy savings over the seven-year life of the fluorescent lamp. (Halogen lamps, by contrast, have a one-year life span.)

In May, Stanford University, one of several universities that had banned the use of halogen torchieres in dorm rooms, began giving students Berkeley's new torchiere free in exchange for their halogens.

Lamps that are based on the Berkeley design are being manufactured by Emiss Lighting of Ellwood City, Pennsylvania. Dubbed the CoolBrite 4000, they are sold at home improvement, lighting, and department stores for approximately \$70 to \$150.—*Arthur Fisher*

Twin banks of cool-burning fluorescent bulbs create 50 percent more light than a halogen lamp.

Castle and incinerated jazz great Lionel Hampton's New York apartment. They're enormously popular, especially among college students, but they are also a serious fire hazard. The typical 300-watt lamp burns at 1,000°F, hot enough to ignite nearby paper, draperies, and furniture.

BUILDING MATERIALS

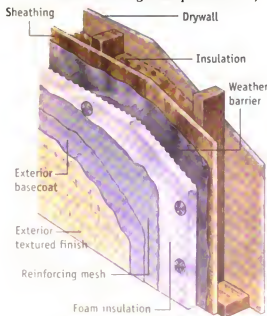
A Stucco Issue

WOULD YOU PUT a siding on your home that keeps water out only when installed perfectly? That's exactly what homeowners with exterior insulation and finish systems (EIFS) did. And now, as a result, some have found themselves the eye of a legal and technological storm.

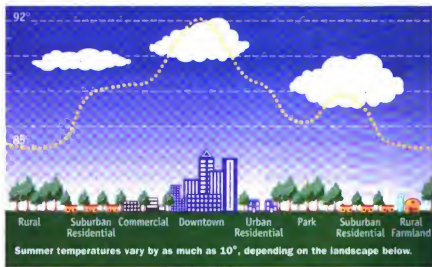
EIFS consists of synthetic stucco applied over foam insulation board that is glued to the home's sheathing. Just like with any home siding, water can seep in behind the siding through gaps. That's why carpenters have traditionally put a drainage gap behind wood or brick siding, then covered the sheathing with water-tight paper.

But EIFS was designed as a barrier system, with no built-in drainage. Any water that got between the foam and sheathing would be trapped. During 1995 and 1996, building inspectors in New Hanover County, North Carolina, found moisture damage in nearly every EIFS home in the area. North Carolina's Home Builder Association observed problems in 90 percent of the homes it inspected.

Following these discoveries, U.S. Gypsum hired the National Research Council (NRC) of Canada to investigate. NRC found that water had entered through wall penetrations,



ENVIRONMENT



Island of Heat

IT'S A BEAUTIFUL summer day—low humidity, moderate temperatures. Perfect weather to explore the museums downtown. But when you reach the city, you have a hot flash—it must be 10 degrees warmer. Some cruel joke of Mother Nature? Not at all. It's the urban heat island effect. Summer temperatures in cities are generally 5°F to 9°F warmer than in surrounding areas, according to *Building Greener Neighborhoods* (\$12 plus \$4.20 shipping, from American Forests, P.O. Box 2000, Washington DC 20013), a paperback published by the Home Builder Press. The most prevalent cause is the scarcity of trees, translating to less shade and a reduced evapotranspiration process, which naturally cools the air with escaping water vapor. In addition, asphalt, concrete, and other building surfaces absorb sunlight and convert it to heat. Automobiles and utilities, such as lights and air conditioners, give off heat as well.—Noah Rothbaum

such as windows and doors, and intersections. The cause was sloppy workmanship.

Jon Carter, a builder from Conyers, Georgia, recently did some EIFS field research for Atlanta's Southface Energy Institute. Almost none of the installations that he looked at included the flashing needed to keep water from seeping around doors and windows. Carter still believes barrier systems can work, but says that it is imperative that they be installed correctly.

Meanwhile, barrier EIFS has been banned in North Carolina and Georgia.

This USG stucco system includes a drainage plane to minimize water damage. It can also be installed without the layer of foam insulation behind the basecoat.

And Maryland Casualty no longer insures homes with barrier EIFS. A number of class-action lawsuits between EIFS manufacturers and homeowners with moisture damage are currently in litigation.

Manufacturers have now bowed to reality; they are introducing systems that include a drainage plane. For instance, in one of U.S. Gypsum's new systems—the InsulScreen 2000-G—drainage channels are cut into the back of the foam, and building paper is fastened to the sheathing. In other words, the new systems function like brick, wood, and other conventional sidings.

Maybe those old-time carpenters knew something about construction after all.—Charlie Wardell

How to make your car invisible to radar and laser...legally!

Rocky Mountain Radar introduces a device guaranteed to make your car electronically "invisible" to speed traps—if you get a ticket while using the product, the manufacturer will pay your fine!



■ The Phazer will "jam" both radar and laser guns, preventing police from measuring your speed.

beat and for some reason I look at my speedometer. After I've passed the trap, my eyes stay glued to my rear view mirror, praying the officer will pass me up for a "bigger fish."

It seems that as speed-detection technology has gotten more and more advanced, speeding tickets have become virtually unavoidable. And although devices exist that enable motorists to detect these speed traps, they are outlawed in many states... including mine.

The solution. Today, Rocky Mountain Radar offers drivers like me a perfect solution—the Phazer. Combining a passive radar scrambler with an active laser scrambler, the Phazer makes your automobile electronically "invisible" to police speed-detecting equipment.

The radar component works by mixing an X, K or Ka radar signal with an FM "chirp" and bouncing it back at the squad car by way of a

waveguide antenna, effectively confusing the computer inside the radar gun. The laser component transmits an infrared beam that has the same effect on laser Lidar units.

Shown actual size, the Phazer is only 3"W x 6"L x 1.5"H!



Perfectly legal.

Some radar devices have been outlawed because they transmit scrambling radar beams back to the waiting law enforcement vehicle. The Phazer, however, reflects a portion of the signal plus an added FM signal back to the police car. This, in effect, gives the waiting radar unit an electronic "lobotomy."

Best of all, unless you are a resident of Minnesota, Oklahoma or Washington, D.C., using the Phazer is completely within your legal rights.

HOW TO MAKE YOUR CAR DISAPPEAR

Radar and laser scramblers are devices that foil speed traps by making vehicles electronically "invisible" to police radar. Radar scramblers mix a portion of the radar signal with background clutter and reflect it back to the squad car. This technique, pioneered by Rocky Mountain Radar, creates an unreadable signal that confuses the computer inside the radar gun.

The laser scrambler is the Phazer works in a similar manner. It transmits a special infrared beam with information designed to scramble the laser signal. The result? Readouts on police radar and laser guns remain blank. As far as the police officer is concerned, your vehicle is not even on the road.

■ The Phazer makes your car invisible to police radar and lasers or the manufacturer will pay your speeding ticket!



How it scrambles radar.

Police radar takes five to 10 measurements of a vehicle's speed in about one second. The Phazer sends one signal that tells the radar the car is going 15 m.p.h. and another signal that the car is going 312 m.p.h. Because police radar can't verify the speed, it displays no speed at all. To the radar gun, your car isn't even on the road.

Works with laser, too! The Phazer also protects your vehicle from Lidar guns that use the change in distance over time to detect a vehicle's speed. The Phazer uses light-emitting diodes (LEDs) to fire invisible infrared pulses through the windshield. Laser guns interpret those pulses as a false indication of the car's distance, blocking measurement of your speed. Again, it's as if your car isn't even on the road.

Range up to three miles.

The Phazer begins to scramble both radar and laser signals as far as three miles away from the speed trap. Its range of effectiveness extends to almost 100 feet away from the police car, at which point you should be able to make visual contact and reduce your speed accordingly.

Ticket rebate program. Rocky Mountain Radar is so confident that the Phazer will protect you from both radar and laser speed-detection devices that if you do get a speeding ticket within the first year while using your Phazer, they will pay your fine!

Encourage responsible driving. While the Phazer is designed to help you (and me) avoid speed traps, it is not intended to condone excessive speeding. For that reason, the manufacturer will only pay tickets where the speed limit was not exceeded by more than 30%, or 15 miles per hour, whichever is less.

Risk-free.

Thanks to the ticket rebate program, speed traps don't make my heart skip a beat anymore.

Try it. Your car will be invisible to police radar and laser, or the manufacturer will pay your fine! It's backed by our risk-free trial and three-year manufacturer's warranty. If you're not satisfied, return it within 90 days for a full "No Questions Asked" refund.

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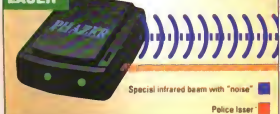
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RADAR



LASER



■ The Phazer is a completely legal way to protect yourself from speed traps (except in OK, MN and Washington DC).



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AUTOMOTIVE

EDITED BY DAN MCCOSH

PREVIEW DRIVE

The Luxury Saab

WITH A HERITAGE of wacky weirdness, Saabs can only get more conventional as they evolve. Proof of that is the Saab 9-5, which hews more closely to mainstream design and handling. The all-new 9-5, expected here in mid-1998 for around \$35,000, extends Saab's model range into the luxury segment. It's larger and more powerful than the 9000 that it will eventually replace.

Saab remains one of the few automakers that are enthusiastic about turbocharging, and both the base 2.3-liter 170-horsepower four-cylinder and the 3.0-liter 200-hp V6 models

With a 0.29 coefficient of drag, the new body is one of the slickest in production. It's also claimed to be among the safest, with a novel triple-path load/crush structure developed to withstand severe offset crashes. Active head restraints, the first in a production car, protect against whiplash.

Touring the hills of central Sweden in the 9-5 demonstrated the softer ride, smoother transmission, and vastly improved throttle response. The new ventilated seats add to the luxury. Gone is the bolt-upright instrument panel of the 9000, replaced by a softer, more sculptured approach that still emphasizes the functional characteristics. The key, however, returns to the floor, an ancient Saab quirk.

To underscore the state of its modern technology, Saab pulled its first effort from its own museum—the thoroughly oddball teardrop-shaped Saab 92, with its front drive powered by a

The 9-5, the first new Saab built specifically for the mid-luxury market, has a softer, rounded look.



use Saab's low-pressure turbo. The smallish unit is calibrated to improve low-end torque, throttle response, and emissions. The V6, with a narrow 54-degree bank angle, also is unusual in using only a single bank of cylinders to power the turbocharger.

The electronic engine control that monitors each cylinder independently allows this asymmetric arrangement. This innovative engine design is responsive underfoot, which is a marked contrast to the 9000's characteristically peaky turbocharger.



Vintage Saabs were advanced in an era of gas-guzzlers. The aerodynamics survived, the two-stroke engine did not.

two-stroke. The smoking engine and skinny tires hardly detract, even today, from the sheer innovation of the lightweight car, created as envisioned by a group of aeronautical engineers obsessed with mechanical efficiency.

It's not a tough act to follow, but it's a tough act to upstage.—D.M.

ALTERNATIVE FUELS

The Ethanol Fleet

BOTH CHRYSLER and Ford have announced their intention to sell large numbers of flexible-fuel vehicles that can run on ethanol, domestically produced from corn. The vehicles will be powered by gasoline, E85 ethanol (85 percent ethanol, 15 percent gasoline), or any combination of these two fuels together.

For Chrysler, this means as many as 200,000 1998-model Caravan, Voyager, and Town & Country minivans will offer flexible-fuel capability as standard fare on all 3.3-liter V6 models. Ford intends to sell 250,000 ethanol flexible-fuel Ranger, Windstar, and Taurus models beginning in 1999, phasing vehicle sales in as an ethanol-refueling infrastructure grows. While GM hasn't yet revealed its plans, a Chevrolet S-10 ethanol FFV program that was put on hold last year is a likely prospect.

It won't be costly to be an environmentally conscious car buyer. Chrysler and Ford are absorbing the approximate \$300 cost of such FFV upgrades as corrosion-resistant fuel lines, a high-capacity fuel pump and injectors, a larger fuel tank to compensate for the less energy-dense ethanol fuel, FFV-specific engine management software, and a fuel sensor that allows these vehicles to run on either gasoline or E85 ethanol.

Now for the reality check: Only 28 public ethanol fueling stations are available, in 13 states. Thus, the hitch: Refueling with gasoline precludes any advantage that owning a flexible-fuel vehicle could possibly provide, such as decreasing tailpipe emissions, cutting oil consumption, and supporting the use of renewable fuels. It doesn't, however, preclude an auto manufacturer from earning substantial Corporate Average Fuel Economy (CAFE) credits for each FFV sold, regardless of the fuel in its tank.—Ron Cogan

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SAFETY

Missing Hits

NO-HANDS DRIVING is reckless, but not for testers on a stretch of highway north of San Diego. One of a number of accident-avoidance demonstrations in the Golden State recently, the roadway that seemed to be encouraging risk actually showed off the ability to guide computer-controlled cars traveling in hands-off safety ["Drive by Wire," Sept.]. Among the participants was Honda, which showcased further technologies aimed at reducing accidents, at its Mojave Desert proving ground.

Honda's automated cruise control is much closer to readiness than the automated highway, whose development is headed by Buick and a brain trust of University of California, Berkeley, researchers. Honda expects production in about three years, while tests on the highway could stretch for about seven.

I drove an Acura sedan that automatically throttled back and downshifted when a laser radar located behind its grille detected a slower-moving car ahead. Then the Acura resumed its programmed cruise speed when I pulled into the fast lane to pass. Honda engineers figure that automated cruise control might cost less than \$1,000.

Considerably further out is a self-driving car. On the big 7.5-mile oval, Honda showed off a small fleet of Accords that can accelerate, brake, and steer without any driver input.

Several of these Accords can travel together as an automated "platoon," with the lead vehicle setting the pace and the following vehicles using radio links and laser ranging to maintain a safe distance apart. This works fine under controlled conditions, but it's anybody's guess how well the automation would perform in the real world, where trash and grime could confuse the sensor system.—Stuart F. Brown

OCTOBER 1997

Popular Science

Nothing Else Compares.

AIRBAGS

A Softer Stop

BEGINNING WITH 1998 models, most new cars will be offered with "depowered" airbags, the result of a new federal rule governing passive restraints. Airbags that inflate with less force are expected to reduce the potential danger to children and some adults who may be too close to the airbags when they deploy in an accident.

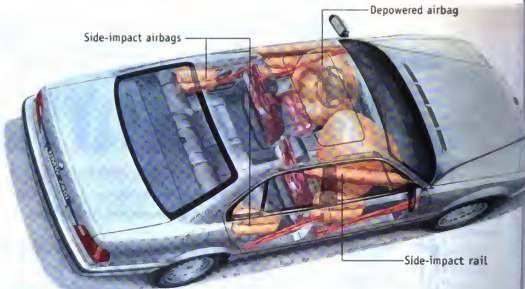
Along with the new bags, which will be 25 percent to 30 percent less powerful than most of those used in the past, some vehicles without a rear seat will have key-operated switches to cut off the passenger-side bag—an acknowledgment that in these vehicles children could be sitting in the front. The switches will also be retrofitted.

Depowering is one of a number of defenses against overly powerful airbags. Redesigning the bag itself to deploy in a pattern calculated to reduce potential injuries is another

solution, as is using sensors that determine the position and weight of the occupant. Neither of the latter two ideas has yet been incorporated in a production car. Mercedes recently introduced a child seat that deactivates the passenger airbag while the seat is in place. BMW is introducing a new side-impact bag system, along with depowering.

The federal directive to reduce airbag power was prompted by sta-

tistics indicating that some people, primarily small women and children, are being injured in relatively low-speed accidents by airbag systems designed to inflate aggressively to protect an unbelted adult male. While several automakers have been conducting campaigns to encourage parents to place children in the rear seat, recent studies indicate that children ride in the front as often as 80 percent of the time.—D.M.



BMW is among the automakers quickly depowering their airbag systems in the 1998 model year. The German automaker also adds a side-impact inflating "rail" for more protection.

PREVIEW DRIVE

Timing Is (Almost) Everything

VARIABLE CAM TIMING isn't new, but Toyota has come up with a fresh interpretation on this theme that makes its all-new Lexus GS sedans—particularly the V8-powered GS 400—some of the hottest rides in their class.

Toyota calls its system continuously variable valve timing, and the difference between Toyota's innovation and other variable cam timing systems is implicit in that name.

The Toyota system can advance intake cam timing across a broad range, and there are no apparent increments in the

advance. The operation of the technology is seamless.

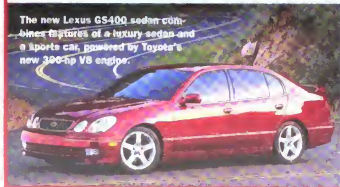
The secret is a helical drive at the end of the intake cam on each bank of cylinders. As power demand increases, the gear slides up and down the end of the shaft, altering the cam timing: simple, ingenious, and effective.

Applied to the Lexus twin-cam aluminum V6 and V8 engines, continuously variable valve timing provides improved operating flexibility and top-end power. In the 24-valve V6, which replaces the previous inline six, output peaks at 225 horsepower. In the V8, new to the GS range, power peaks at a robust 300 horsepower (280 in the LS 400). Allied with a new five-speed automatic transmission, that's enough to propel this previously sluggish rear-drive sedan to 60 mph in a mere 6 seconds.

During a day of driving mountain roads east of San Diego, our GS 400 exhibited an appetite for hard turns, hard acceleration, and equally hard braking that's on a par with the best in the luxury sport-sedan class.

Lexus hadn't announced pricing at press time, but we'd guess that the cost of a loaded GS 400 will probably top out at about \$55,000.—Tony Swan

The new Lexus GS400 sedan combines features of a luxury sedan and a sports car, powered by Toyota's new 300-hp V8 engine.



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SAFETY

Early Warning

A MICROWAVE sensor to detect moisture, snow, and ice is being developed by researchers at the University of Wyoming in Laramie. The low cost and simplicity of the sensors promise to allow more accurate and widespread weather monitoring on the nation's highways, researchers say. An array of

the small, cheap sensors along the side of the road would be capable of alerting drivers to icing, as part of a network of early-warning systems for drivers, or they could monitor icing patterns for research on how such patterns are formed.

The detector works by sending out two microwave signals, and then compares the direct and reflected patterns of the signals to determine the moisture content and atmospheric condition.—D.M.

PREVIEW DRIVE

Topless Corvette

SOFT-TOP CORVETTES have been objects of adoration since Ike was president. Chevy launched the fifth-generation 1998 Corvette early this year as a coupe, with a re-engineered chassis and a new aluminum engine lighter and more powerful than the engine it replaces. The fully convertible version is virtually identical in its fundamental details.

Beyond the folding top, the major change is the addition of two composite-plastic access panels. One opens up the 11.1-cubic-foot trunk, the other conceals the stowed top. Sculpted and painted surfaces blend in the headrests and cascade down behind the seats to meet the center console. No mere styling flourish, this fixed center panel hides the structural panel bracket that provides a secure latching point for the rear-hinged top cover.

Saving bulk, weight, cost, and complexity, Chevrolet resisted the

urge to engineer a one-button power top. The manual-folding design makes sense because it's so easy to use: Swing two windshield-header latch handles and press one button to release the cover panel. Raise the top's front edge, then the rear edge, then the cover panel. (An innovative over-center linkage makes rear latches unnecessary.) The folded assembly is then lowered out of sight behind the seats.

With the top erect, the Corvette convertible is only slightly noisier inside than the semiconvertible targa model. The world's stiffest convertible underpinnings deliver a ride that's free of twists, creaks, and rattles. With the top down, the jet blast around the windshield can be modulated merely by raising the side windows. But why bother? Knotted hair and a sunburned neck are what distinguishes happy convertible owners from ordinary motorists. The price of the wind-in-the-face version is \$45,000.—Don Sherman

The new Corvette convertible supplies wind in the face with no structural compromises.





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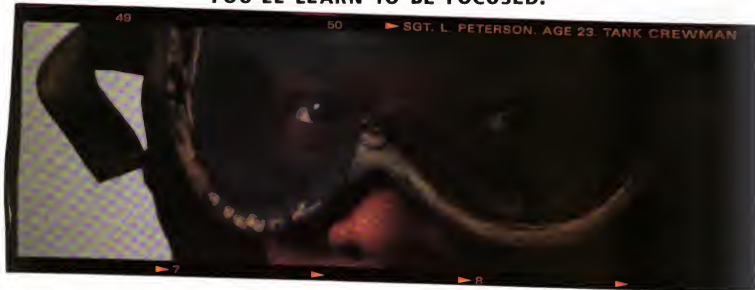
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COMPUTERS & SOFTWARE

EDITED BY CHRIS O'MALLEY

GAMES

Network Players

COMPUTER GAMES have traditionally been solo adventures—or at best it's you against the artificially intelligent computer. But this fall a new category of game will hit store



Net Storm is a troop placement and flanking game. Headland Digital Media's **Net War** (left) brings combat to the Net.



keep fighting until you return.

Virgin Interactive's SubSpace, a space shoot-'em-up game, handles up to 120 players. You can team up with other players or go it alone. To get around latency issues, Virgin gives the spaceships large turning radiuses. This enables your computer to more accurately predict the movement of opponents, resulting in smoother play.

Not all of the new Net games are of the action genre. Role-playing games like Origin System's Ultima Online and simulation games like Cryo Interactive's Intervention (a God simulation game) and Imagic Online's Warbirds 2.0 (a World War II air-combat simulator) have been designed for human interplay via the Internet.—*Suzanne Kantra Kirschner*

shelves: CD-ROM games that not only support Internet play, but require an opponent via the Net.

These games overcome or work around the Internet's greatest gaming flaw: lag time, or latency. Activision's Net Storm, for example, retains the action of a traditional combat strategy game but dodges the latency problem by removing troop micro-management. You can place troops, but you can't direct individuals. And if you're disconnected, your soldiers

E-MAIL PROJECTIONS

Pumping Up the E-Volume

ELECTRONIC MAIL USE is exploding. The numbers below show the projected growth in e-mail users and messages, at work and at home, in North America.



1997	67 million e-mail users	2.7 trillion messages sent
1998	81 million e-mail users	3.9 trillion messages sent
1999	96 million e-mail users	5.4 trillion messages sent
2000	108 million e-mail users	6.8 trillion messages sent

Source: Electronic Messaging Association

ONLINE

PCs Go Postal

SNAIL MAIL MAY soon be getting some electronic legs. The U.S. Postal Service is quietly working with several companies to begin offering electronic stamps later this year—and possibly a host of other computerized mailing services down the road as well.

Postage meters will be first to go digital. The Postal Service says it will soon authorize several companies to sell electronic postage over the Internet. Upstart firms such as E-Stamp Corp. of Palo Alto, California, and Neopost of Hayward, California, have developed electronic postage meters, and meter king Pitney Bowes is working on a similar system. The E-Stamp and Neopost schemes would each enable you to purchase postage credits from a Web site, which would be downloaded to a small electronic device that sits between your PC and printer. You can then print a special postal bar code, or indicia, onto envelopes or labels. Security software would keep out anyone who might be seeking to pilfer your printer's postage.

The Postal Service is expected to authorize one or more of these systems by year-end as part of its goal to replace mechanical meters by March 1999. Eventually, the Postal Service intends to offer a series of electronic services, including an e-mail postmarking system that uses encryption. Thanks to a new postal "digital signature," the system lets e-mail senders and recipients verify when an e-mail was sent and be sure it has not been tampered with. Return receipt, certified, and registered e-mail services are in the works, too. Many of these services should be available in 1998—if the post office delivers on time.—*C.O.*

GRAPHICS

3-D Booster Shot

MAKE ROOM FOR yet another must-know acronym in your computing lexicon: AGP. The new Accelerated Graphics Port interface is designed to speed up the display of graphics on Windows PCs—particularly games with 3-D graphics. It should also have pleasant side effects—reducing the need for so much dedicated video memory on 3-D graphics cards, which may, in turn, reduce their cost.

AGP is actually an internal interface or link between the graphics-controller chips on today's 3-D cards and your PC's system memory (or RAM). This express lane bypasses the PC's main data artery, or bus, speeding transfers of high-volume graphics information from controller to screen. PCs with AGP can move graphics data up to four times faster than today's models, which can result in more detailed and fluid images onscreen. And since AGP allows a video card to use a system

memory for 3-D functions such as texture mapping and z-buffering, there's less need to load up video cards with dedicated memory of their own. Many 3-D cards now come with 4- or even 8MB of dedicated video memory, which hikes their cost (or the cost of the new system that they come with).

Getting AGP is not as simple as plugging in a new 3-D card, however. AGP requires a new motherboard design, which will be incorporated into many new PCs later this year. Most will be systems using either Pentium II or Pentium Pro microprocessors. Acer, Compaq, Dell, Gateway, Hewlett-Packard, IBM, NEC, Sony, and Toshiba are among the computer makers who say they'll incorporate the AGP in their new systems. All of the major 3-D card makers say they'll support AGP as well. Existing 3-D games and other graphics software will work with AGP without modification. New games can be optimized for use with AGP. Some new arcade game machines built around Pentium II chips will use AGP, too.—C.O.

MULTIMEDIA

Audio Gymnastics

FOR MORE THAN a decade, about the only thing you needed to know about the sound card in your MS-DOS or Windows PC was whether it was compatible with Creative Labs' Sound Blaster cards. You may want to take a closer look—or listen—to your next sound card, however.

Creative Labs is still at the forefront. Its new Sound Blaster Awe64 card can play as many as 64 distinct voices. And in addition to wavetable synthesis, which plays back the pre-recorded sounds of actual instruments, the Awe64's software supports the physical modeling of sounds, a mathematical approach that can produce a wider range of sounds.

The next audio frontier for PCs is better surround sound. Creative and Diamond Multimedia are among those using new "positional audio," which can not only deliver the perception of sounds coming from the right and left (as 3-D audio does), but also from above and below.—C.O.

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—Suzanne Kantra Kirschner



The Invisible Home Network

THE PROSPECT OF a computer conversing with a host of "smart" appliances in your home may be a giant step closer to reality, thanks to a breakthrough in wireless technology at IBM's T.J. Watson Research Center in Yorktown Heights, N.Y.

IBM researchers have developed a radio frequency (RF) wireless transmission system that can send and receive data without errors at speeds up to 10 megabits per second (Mbps), comparable with the wired Ethernet networks used in many companies today. Current wireless networking systems usually rxnax out at 2Mbps. More important, perhaps, IBM says it has achieved wireless speeds as high as 38Mbps under laboratory conditions—a speed that could easily transmit full-motion video and other high-bandwidth types of information.

RF is considered a key technology for future home networks because of its low cost and simplicity. There would be no need to rewire your home, for example, and radio signals can work through walls, ceilings, and furniture (unlike light-beam technologies, such as infrared). The key to IBM's breakthroughs is new algorithms and codes that eliminate the multipath, or signal, reflection problems associated with indoor RF systems. IBM's patent-pending system is the first to use the FCC's recently allocated radio range that is known as the Unlicensed National Information Infrastructure spectrum.—C.O.



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GAMES

Rubik's Reduced

"WE TURN THE cube, and it twists us." That's how Erno Rubik described the puzzle he invented in his mother's Budapest apartment in the late 1970s. Indeed, Rubik's cube has baffled and tormented millions of people over the years. No wonder: More than 43 quintillion possible combinations can be formed by twisting the cube, which has colored stickers on the faces of the 26 exposed sub-cubes, or cubies. (One cubie is buried at the center of the cube.)

Now Richard Korf, a professor of computer science at UCLA, claims to have found the optimal so-



lutions to the cube, using a program running on a Sun workstation computer. Previous strategies typically required 50 to 100 moves. But Korf's research shows that most scrambled cubes can be solved in no more than 18 moves. Korf generated 10

random scramblings. One was solved in 16 moves, three were solved in 17 moves, and the rest in 18 moves. The computer time required ranged from several hours to several weeks.

Korf's research should help in other combinatorial problems where optimum solutions are needed, such as routing and scheduling quandaries. As Rubik himself once said, "The problems of puzzles are very near the problems of life; our whole life is solving puzzles."—Arthur Fisher

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Proton Memories

WHAT'S THE WORST teeth-grashing nightmare that can befall you as you sit before a computer? Easy. It's when you've forgotten to save the enormously important document you're working on, and suddenly a power outage or other mishap causes the machine to shut down, thereby losing hours of your work.

That sad scenario could soon be a thing of the past. A partnership of scientists at Sandia National Laboratories and France Telecom have applied for a patent on a prototype memory-saving device that is simple to produce, low-powered, and inexpensive. Described as protonic, the device stems from the observation that protons remain fixed in silicon that is baked at high temperatures in a sea of hydrogen gas. As the gas permeates a chip, it dissociates into single hydrogen ions—protons—at defects in the silicon dioxide layer, defects that were created by heat in

the chip-manufacturing process. The protons can migrate only in the middle layer of the silicon-silicon dioxide sandwich.

Key to the chip's operation is this: When a positive low voltage is applied to one side of the silicon, protons are repelled to the far side of the silicon dioxide. When a negative low voltage is applied, protons are attracted to the near side. And if the power is turned off for any reason, the protons remain on station, thus embedding and saving your crucial information.

The work is part of Sandia's research for the Defense Advanced Research Projects Agency, which seeks radiation-hardened, low-voltage chips that could survive nuclear blasts. There have been many previous attempts at so-called static memories that promised to save what's on the screen in case of disaster, but none of them has been widely used, mainly because they are expensive to produce.—A.F.

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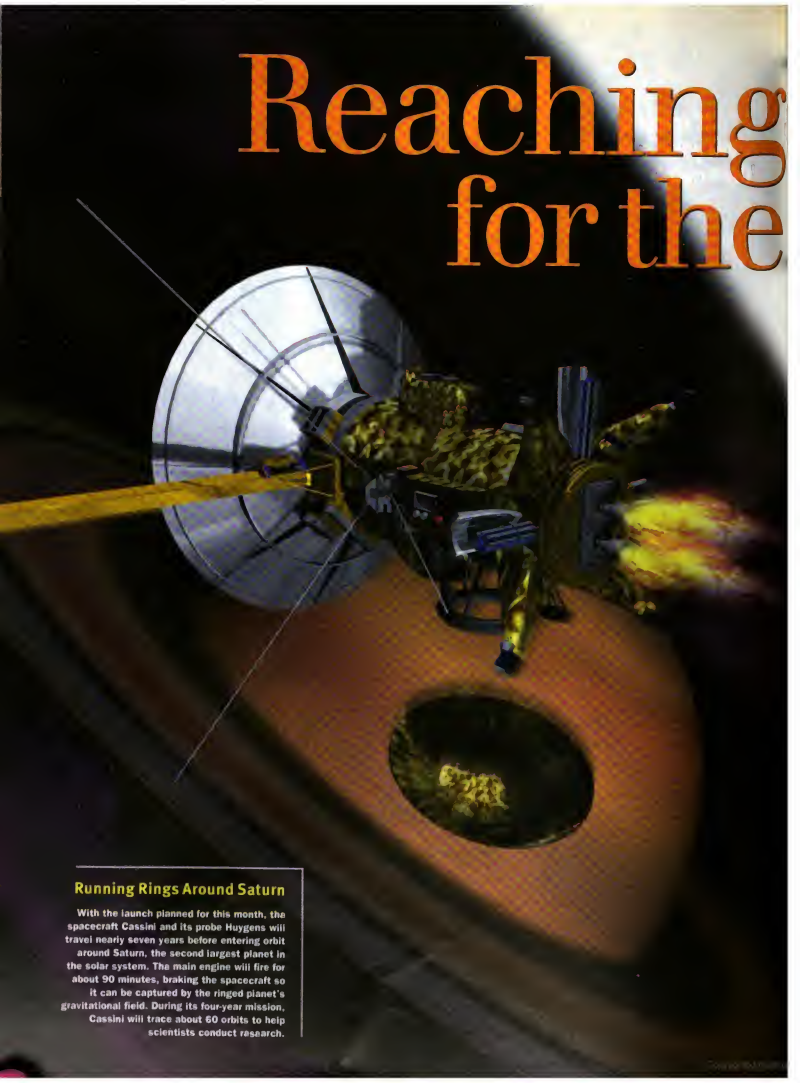
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Reaching for the



Running Rings Around Saturn

With the launch planned for this month, the spacecraft Cassini and its probe Huygens will travel nearly seven years before entering orbit around Saturn, the second largest planet in the solar system. The main engine will fire for about 90 minutes, braking the spacecraft so it can be captured by the ringed planet's gravitational field. During its four-year mission, Cassini will trace about 60 orbits to help scientists conduct research.

Rings

The biggest,
best, and last of
NASA's superships,
Cassini takes off
for Saturn.

VENUS AND EARTH have disappeared astern, and even Jupiter is now a fading dot of red and orange. Only Saturn lies ahead. The ringed planet and its strange collection of moons will be the final destination for a huge traveling space laboratory called Cassini. There, the biggest, the best, and the last of America's superships to the outer planets will settle in to complete a long decade's work.

Cassini's herculean mission begins this month with its launch from Cape Canaveral aboard a Titan 4B Centaur rocket. It won't end until 2008, or later.

By Jim Schefter

By then, the chore of exploring our solar system will have been turned over to smaller explorers, midgets by comparison with the big ship named for the Italian-French astronomer who discovered four of Saturn's moons.

The next generation of deep-space craft will trek among the planets at a fraction of Cassini's estimated total cost of \$2.7 billion, although

ILLUSTRATIONS BY DON FOLEY

Lengthy Journey

Cassini's tour of the solar system will be complicated: Launched from Earth, it will fly past Venus twice, then Earth, and finally Jupiter—getting a gravity assist from each of these planets before it heads for Saturn.



with a fraction of its capabilities. The future belongs to the micro-ships. (For information on a microship in action, see "Back at Mars.") But first, Cassini:

- Its seven-year outbound voyage will send it skimming past three planets (including Venus twice) before it goes into orbit around Saturn—the first spacecraft ever to do so. Earlier missions that visited Saturn—Pioneer 11 in 1979 and the twin Voyagers in 1980 and 1981—were strictly flybys.

- In a minimum four-year sojourn around the ringed planet, Cassini will zoom close to icy moons, send home the best-ever close-up photos of those rings, and give us detailed looks at Saturn itself.

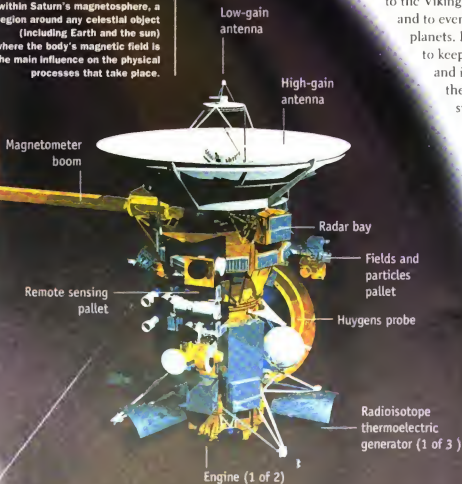
- Within months after settling into the Saturnian system in July 2004, Cassini will drop a large probe called Huygens (after the Dutch astronomer) to the surface of the moon Titan. Scientists don't yet know whether Huygens will land in a frigid ethane sea or on dry land. But

before it succumbs to the alien environment, Huygens should transmit enough data to tell us why

Titan is the only moon with a substantial atmosphere of its own and whether life could be percolating in the moon's oceans.

Anatomy of Cassini

Cassini's scientific sensors will support 27 different investigations of Saturn. Half the instruments are designed to measure the particles, magnetic field, and radio emissions within Saturn's magnetosphere, a region around any celestial object (including Earth and the sun) where the body's magnetic field is the main influence on the physical processes that take place.



At the Jet Propulsion Laboratory in Pasadena, California, Cassini program manager Richard J. Spehalski looks to his ship's future with both excitement and a measure of sadness. When Cassini finally becomes derelict sometime in the early 21st century, a spark of the human spirit will die with it.

The 6.4-ton Cassini, the size of a small bus, may not be politically acceptable in the low-budget 1990s. But if it completes major portions of its ambitious mission, it will be hailed by the scientists who need its mounds of data to decipher the riddles of space. And even the politicians who decry the cost of space exploration will be cheering.

To save money and weight, Cassini will be sent on an intricate Venus-Venus-Earth-Jupiter (VVEJ) gravity-assist trajectory. It will swing past Venus six months after launch, picking up speed and altering its course. Fourteen months later it will graze Venus again, picking up more speed and hurtling back toward Earth.

In August 1999, Cassini skips past Earth, again adding speed and now zooming outbound toward Jupiter. On December 30, 2000, the big ship will get a final gravity boost from Jupiter and aim toward Saturn.

The VVEJ trajectory saves the equivalent of 77 tons of fuel, but it adds years to the mission's duration. During most of the interplanetary cruise, Cassini's instruments will be in a dormant mode and its big fixed antenna will be pointed toward the sun to shield the spacecraft from destructive solar heat.

"This one is worth staying around for," says JPL's Ellis Miner, who is a veteran of planetary missions going back to the Viking ships that landed on Mars in the mid-'70s, and to even earlier craft that first paved the way to the planets. He will stay at JPL past standard retirement to keep a hand in directing Cassini science work and in analyzing the results. "This is the last of the missions where there is a high degree of synergism among the onboard investigations," he says.

In addition to the Huygens probe destined to sink into Titan's sea, Cassini carries a dozen of the most advanced instruments ever sent to the outer planets. The most exciting information will come from its cameras, transmitting full-color photos in visible, ultraviolet, and infrared bands. Close-ups of the icy surfaces of moons like Enceladus and Tethys from earlier missions have brought gasps from scientists. Cassini's photos promise to be even clearer and more detailed.

The giant moon Titan is covered with clouds, but special filters on Cassini's cameras may enable us to get a look at

New View on Titan

Imaging radar aboard Cassini will map the surface of Titan, which is today obscured by the moon's atmosphere. The orbiter's high-gain antenna will use the Ku-band frequency, one of four frequencies at which the antenna can operate. The images will reveal new information about the moon's structure, geology, and other surface characteristics.

Titan's surface. And the spacecraft's radar will penetrate the clouds to give us surface maps with elevation details equal to or better than high-altitude photography of Earth.

Six separate spectrometers aboard Cassini will relay information ranging from the chemical compositions of Saturnian rings and the surfaces of its moons, to details about the atmospheres of Saturn and Titan, to analyses of the interplanetary gases and plasmas in the region.

A cosmic dust analyzer will check out the size and composition of ice and dust grains around Saturn and its rings. A magnetometer will study Saturn's magnetic field, and another imaging instrument will look at the flow of solar gases around Saturn.

Finally, Cassini's radios will be used to search for gravitational waves, and to provide measurements of Saturn's atmosphere, rings, and gravity fields. Such information could help explain how rings form and evolve—not just around Saturn, but also Jupiter, Uranus, and Neptune.

The abundance of instruments gives Cassini significant powers. "Some newer missions are so pre-programmed that they can't react to the unexpected," Miner says. "When we see something new and exciting—and we will—we'll be able to get a great deal of information, and we'll be more likely to understand what's happening."

It's the Huygens probe, supplied by the European Space Agency, that has scientists most excited about the early months of Cassini's long stay at Saturn. The 9-foot-diameter probe will drop through Titan's thick nitrogen atmosphere under a parachute.

Huygens has its own set of cameras and instruments. During its descent, which will take about 2½ hours, the

Next-Generation Explorers

THE 16-POUND SPACECRAFT basking under Ross Jones' fond gaze is no bigger than a bread box, with a camera about the size of a cigar.

It's the latest design from the Jet Propulsion Laboratory aimed at continuing planetary exploration when the last of the research battleships—Galileo already at Jupiter and Cassini heading for Saturn—are gone. Jones delivers a new and ever-tinier spacecraft every six months to demonstrate the latest technology available for fulfilling NASA's faster-better-cheaper goals. His latest iteration, which could study near-Earth asteroids, features:

- Tiny rockets for attitude control. In the old days, little jets like these were called "mouse farts." The version on Jones' craft is more suited to a flea.
- Fuel-carrying tubes in the spacecraft structure. Jones and his team have adapted "wet-wing" airplane engineering to spacecraft, saving weight and adding strength.
- A miniature star tracker for onboard navigation.
- A four-cube design with fuel tanks in the center. Avionics systems fit into one corner, or cube, of the ship; the camera system into another; and additional scientific instruments into the remaining two cubes.
- A multilevel computer chip design that conducts current through all four of its edges, rather than through a central connector. This may have widespread applications. For now, it allows spacecraft electronics to do much more in the same volume as standard systems.
- A tiny active pixel sensor video camera. The camera

yields high-resolution images but draws only milliwatts of power.

One big problem: The tiny valves in the propulsion system are almost impossible to seal. Jones' solution is to begin designing spacecraft that use solid propulsion fuels.

Meanwhile, Jones and his team are rethinking the basic structure of spacecraft, says John Cardon, the team's expert in that field. "The structure is basically disappearing as the spacecraft get smaller. We're going to end up with instruments that are their own structure and maybe have some things stuck on the outside." —J.S.

Tomorrow's explorers: This "nanorover" design might visit a comet.



Back at Mars

"WE'VE GOT a perfect landing site, perfect instruments, and a perfect rover," beamed Matthew Golombek, the project scientist for Mars Pathfinder, on July 6. "We're all more excited than we could possibly believe."

Two days earlier, on Independence Day, the Pathfinder lander had executed a "bump-down" on the Red Planet. Then, on July 5, the lander released a 22-pound rover called Sojourner, the first wheeled vehicle on the surface of another planet. Pathfinder's landing marked the first exploration of the martian surface since the Viking missions in 1976.

Pathfinder, however, exemplifies a new way of doing things, in keeping with NASA's faster-better-cheaper motto. In contrast to the \$3 billion price tag for the two Viking missions, the Pathfinder program cost is estimated at \$266 million. For engineers at NASA's Jet Propulsion Laboratory, Pathfinder's safe arrival proved the worth of a fuel-saving landing system featuring inflatable airbags.

Since then, Pathfinder has pro-

vided a flood of data—in more ways than one—that has made Golombek and his science team ecstatic. The lander has sent back spectacular images of its landing site, a rocky plain near the mouth of a channel called Ares Vallis that is thought to have been carved by running water sometime between 3 billion and 4 billion years ago. According to geologist Michael Malin, the deluge may have released 100 million cubic yards of water every second for a period of perhaps hours or days. "It's hard to visualize this kind of flood," Malin says. "This was huge."

In addition to offering such clues to Mars' watery past, rocks at the landing site appear to have been shaped by meteorite impacts and volcanic activity, and there are signs of windblown dust. Says geologist Ron Greeley, "We chose this site because we wanted to see the geologic diversity on Mars."

And we have not been disappointed."

Sojourner's performance has also been cause for celebration. Despite some trouble with a balky communications system, the rover has sent back valuable data about the composition of rocks and soil. The results have been intriguing: The first rock that the rover studied, nicknamed Barnacle Bill, turned out to be surprisingly rich in quartz. If Bill is volcanic, as some scientists suspect, it supports the idea that the martian interior has undergone a lengthy and varied history of melting, cooling, and remelting.

Sojourner has performed so well that scientists expect it to operate for weeks or months, and there are hopes that the Pathfinder lander (which NASA has renamed the Sagan Memorial Station) will survive until next March, when the Mars Global Surveyor spacecraft will begin mapping Mars from orbit.—Andrew Chalkin



A Look Inside Sojourner

The Mars microrover can place its alpha proton X ray, or APX, spectrometer in contact with a rock or patch of soil to measure the elemental composition so scientists can determine the minerals present. Three radioisotope heater units keep Sojourner warm; each contains less than one-tenth of an ounce of plutonium-238, which gives off about 1 watt of heat. A porous, nearly weightless silica material insulates the electronics box.



1 Probe enters Titan's atmosphere.

2 A small parachute is released, deploying the main chute.

3 After jettisoning the decelerator shield, the probe drifts downward, all the while relaying data from its instruments to the Cassini orbiter.

Dropping by Titan

Cassini's probe, Huygens, will delve into the mysteries of Saturn's moon Titan during a 2.5-hour descent to the surface. Slightly larger than the planet Mercury, Titan is the only moon in our solar system with an Earth-size atmosphere, forming a hazy blanket over the surface. Some have speculated that Titan may have continents, and oceans of liquid ethane.

4 At 25 miles in altitude, Huygens ejects the main chute, and a drogue chute opens to descend the rest of the way to the surface.

5 If the probe survives the 15-mph impact with the surface, it will transmit data for about an hour.



probe will analyze cloud chemistry, take wind measurements, and look at suspended particles. Data will be relayed to Cassini, and then be retransmitted to Earth.

Once clear of the clouds, and now dropping under a drogue chute designed to keep Huygens stable, the probe will photograph Titan's surface. Astronomers have speculated that the giant moon could have a partially solid surface, and lakes or huge oceans of liquid ethane or methane. Titan may be the only other object in the solar system, besides Earth, that has shorelines, says Miner.

The probable landing spot will be in one of those frigid lakes or seas, he says. If Huygens survives the landing, its battery will work for about an hour, and a package of instruments will take readings of the surroundings. Then it will either go dead on dry land or sink into the organic sea.

Cassini will continue to explore the Saturn system for another four years after Huygens completes its piece of the mission. The spacecraft's orbit will be changed frequently to dip into the rings, and to swing out and fly close to at least four of Saturn's moons.

Orbital periods around Saturn will take as little as 16 days, or as many as 30 to 40 days. Program manager Spehalski compares the pressure and workload to the Voyager spacecraft, which flew through the Saturn system but didn't stick around to watch things change: "Voyager required intense activity here on Earth for about 10 days," he says. "We're going to do the equivalent of a Voyager encounter every month for four years, with some of the encounters coming every 16 days."

Getting data back to Earth is always a problem on deep

space missions. Cassini's plan calls for the giant laboratory to take photos and record measurements with its instruments for 16 hours each cycle, then spend the next 8 hours transmitting the data to Earth.

At the same time, Spehalski and his ground team have to be ready for trouble. "This will not be a fault-free mission," he says with a shrug. "Cassini has to do a lot of things, and many of them autonomously because of the time delay."

"We designed it from a mechanical sense so that it's like an observatory, like a Hubble. You move the whole damn machine to get some things done."

The sophisticated onboard software will monitor activities, particularly during the long quiet periods of coasting toward Saturn. If something goes wrong, computers will automatically look to backup systems. "Then it will be up to us to figure out why Cassini did what it did," Spehalski says, grinning. Those kinds of riddles will keep the ground team sharp during the long years of travel. And if the computer can't find a solution, it will simply put the craft into a waiting mode until controllers on Earth can figure out what to do.

Spehalski may be an advocate of big, multitasking spacecraft. But he recognizes the ascendancy of the faster-better-cheaper philosophy of doing space science. "It's just too bad that we didn't look at ships like Galileo and Cassini as deep-space relay stations," he says. "We should be sending smaller craft to follow them out there and do the specialty investigations."

"We're going to have this big, expensive asset sitting out there. Why not make better use of it?" ♦

Reports on the death of the personal digital assistant were apparently premature

By Suzanne
Kantha
Kirschner

Return of

WHEN APPLE INTRODUCED the Newton in 1992, a new product category was born: the personal digital assistant, or PDA. The promise—and the hype—seemed boundless: a computer that could organize your life, read your handwriting, and fit in your pocket. Trouble was, the early PDAs were a crude, cranky lot that didn't deliver all they promised. The Newton's unpredictable handwriting recognition quickly became more popular as a party game than as a useful tool. The early PDAs were also too big for most pockets and didn't communicate easily with the outside world. Not surprisingly, PDAs bombed.

But even with this miserable beginning, the notion of a digital helper was too good an idea to be squashed. And indeed, U.S. Robotics resurrected the PDA in 1996 with its Pilot. A sleek device only slightly larger than a deck of cards, the Pilot was small enough to slip into a suit jacket pocket without making an ugly fashion statement. More important was that, rather than attempting to fly solo, the Pilot was designed to be, well, a co-pilot of sorts, serving as an untethered adjunct to your primary computer. Your appointments, contacts, notes, to-do lists, and expenses could all be synchronized with your desktop PC by seating the Pilot in its cradle and pushing a single button. It even had a form of handwriting recognition, called Graffiti, that was fairly reliable.

Since then, a slew of PDAs have followed, including a new version of the Pilot called the Palm Pilot Pro. The Pilot now has an emulator, too, in Sharp's new SE-500. There's yet another new edition of the Newton, called the MessagePad 2000, and a new model 5 from veteran PDA manufacturer Psion.

Then there was the big shoe that dropped. Microsoft

finally got around to releasing a version of its Windows operating system specifically for pocket PCs, dubbed Windows CE, and that unleashed a small torrent of entries from the likes of Casio, Compaq, Hewlett-Packard, Hitachi, NEC, and Philips. (Of this group, we evaluated the Philips Velo 1 for this report.)

Are these new-and-improved PDAs all you've been wishing for? Not likely. But they're a lot closer to the bull's-eye than when the first Newton fell from the Apple tree, and some fundamental lessons have clearly been learned.

Lesson one: The human hand is not designed to enter lots of data into a small machine. The tiny keyboards and spotty handwriting recognition are just too finger-numbing for that. So nearly every PDA now can get information from desktop PCs, as well as give it.

Lesson two: PDAs are by definition portable and are used under poor lighting conditions, like the backseat of a taxi or the darkened cabin of an airplane. The new PDAs have backlit displays.

And lesson three: Communication is absolutely critical. Modems and e-mail software are now either standard built-in features or available as options on every PDA. Still, PDAs



PHOTOGRAPHED BY JOHN B. CARNETT

PDA's the PDAs

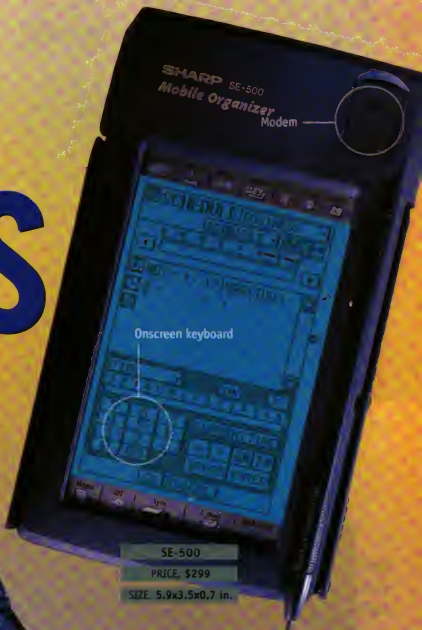


Psion 5

PRICE: \$599

SIZE: 3.5x6.7x0.9 in.

Keyboard slides out for more comfortable typing



SE-500

PRICE: \$299

SIZE: 5.9x3.5x0.7 in.

One-touch program access



You can send and receive e-mail via the SE-500's built-in 14.4Kbps modem.



Record, stop, and play buttons let you record voice memos without turning on the Psion 5.



NAME	PSION 5	MESSAGEPAD 2000	PALM PILOT PRO	SE-500	VELO 1
MANUFACTURER	Psion	Newton Inc.	U.S. Robotics	Sharp	Philips
PRICE	\$599-\$699	\$949-\$1,099	\$399	\$299	\$699-\$739
MODEM	Optional: PC Card adapter (\$139) plus modem, or 14.4Kbps travel modem (\$249)	Optional: PC Card modem	Optional: proprietary modem (\$129)	Yes, 14.4Kbps	Yes, 19.2Kbps
PC CONNECTION	Serial cable; infrared; includes links to 2 popular organizer programs	Serial cable; infrared; includes links to 2 popular organizer programs	Desktop cradle; additional purchase for link to popular organizer programs (\$69)	Desktop cradle; includes links to 3 popular organizer programs	Desktop cradle; includes links to Microsoft Schedule 7.0a
SIZE (INCHES)	3.5 by 6.7 by 0.9	8.3 by 4.7 by 1.1	4.7 by 3.2 by 0.7	5.9 by 3.5 by 0.7	3.8 by 6.8 by 1.0
WEIGHT (OUNCES)	12.5	20	5.7	6.5	14.8
SCREEN RESOLUTION	640 by 240 pixels	640 by 320 pixels	160 by 160 pixels	240 by 159 pixels	640 by 240 pixels
INPUT TYPE	Integrated keyboard	External keyboard, handwriting recognition	Onscreen keyboard, Graffiti handwriting recognition	Onscreen keyboard	Integrated keyboard
EXTRA FEATURES	External voice memo activation	Internet browser preinstalled	Large selection of 3rd party software available	Zero-touch synchronization when in cradle	External voice memo activation, Internet browser preinstalled
OPERATING SYSTEM	EPOC32	Newton 2.1 OS	Palm OS	Sharp OS	Windows CE

are far from cookie-cutter devices—or experiences.

If you're on the road often with a PDA as your portable computer, then size may matter less than a PDA's ability to collect and communicate information. The Newton

MessagePad 2000, with its external keyboard and 640- by 320-pixel display, is by far the best choice if you're going to type long memos and e-mail, or work on spreadsheets. And its pair of PC Card slots enable you to use the latest

modem technology while leaving room for extra storage. But you'll have to weigh that against the fact that this is a heavy and, with the separate keyboard, clumsy PDA. And chances are, you don't want to leave the keyboard. The Newton's handwriting recognition is vastly improved, but if you got less than a B+ in penmanship, it probably won't work well enough.

In the more likely event that you're reviewing documents and responding to e-mail rather than creating lots of original material, the compromise embodied by the Velo 1 and Psion 5 may make for easier traveling. They



Browse the Internet with the Velo 1's built-in 19.2Kbps modem.



The Pilot Pro's docking station provides one-button synchronization with a desktop computer.

are substantially smaller and lighter than the MessagePad; and have built-in, if very small, keyboards. The Velo has a built-in modem and takes miniature flash memory cards for extra storage; the Psion has a PC Card slot for a modem or extra file space. They have reasonably equipped spreadsheet and word processing programs, and the Velo comes with an Internet browser.

You'll find typing to be a pleasant experience on neither. The Velo has a standard layout but tiny button-style keys. The Psion's keys are much larger, but keyboard layout is not the traditional qwerty style.

If you're merely looking for a way to keep track of all those brilliant ideas that only seem to pop into mind outside the office, you may not need the keyboard at all. The Psion and Velo each have a voice memo function that you can use even when they are closed up.

If you don't mind jotting things down, you can choose an even lighter traveling companion. The smaller Palm Pilot Pro uses the Graffiti handwriting recognition system rather than a keyboard. You'll have to learn the Graffiti alphabet, numbers, and punctuation, but it's a familiar, intuitive, and forgiving system. The Pilot Pro can track expenses and help you create, read, and reply to e-mail. But all e-mail is sent and received via your desktop PC unless you install additional software and buy the travel modem.

If you don't plan on inputting much of anything, but want to stay in touch, Sharp's SE-500 may be your ticket to ride. It comes with software to send and receive Inter-



The MessagePad 2000's handwriting recognition software can read cursive and printed characters.

net e-mail via its built-in, if a bit poky, 14.4Kbps modem. But entering data or responding briefly to e-mail messages can be a chore with its minuscule

onscreen keyboard; canned e-mail responses are available.

Not sold yet? PDAs with color screens from Sharp, Casio, and others are coming later this year and next. More Pilot clones seem inevitable, too, with Microsoft reportedly working on a new PDA operating system more attuned to the Pilot's strengths. The long-awaited marriage of phones and computers may finally be consummated with new PCS voice-and-data services, too.

Who knows? With so many PDAs coming, you may yet find a pocket computer that's just your size. ♦

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■ The Ultimate Challenge - try holding two! #DF-PAIR \$34.90 Save \$9.00.

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You know it's working even in the brightest light. Curved, low profile design rides lump-free in your pocket. Adjustable flame, will fuse metal or light up your smoke. Butane powered. Great price!

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■ The Phantom Detector/Jammer Device, #RP-200 \$299.95

Measures just 4" x 4" x 1.5" H. Certain restrictions apply on ticket rebate program, to ensure you do not intentionally drive recklessly. Drive responsibly. No device will save you tickets (or worse) if you drive foolishly. If you're going 90 mph, an officer hardly needs a radar gun to catch you. His eyes will do. Not available where prohibited by law.



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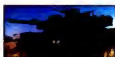
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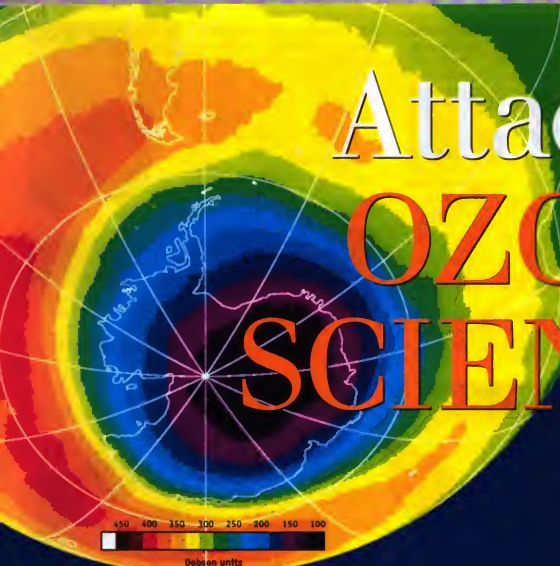
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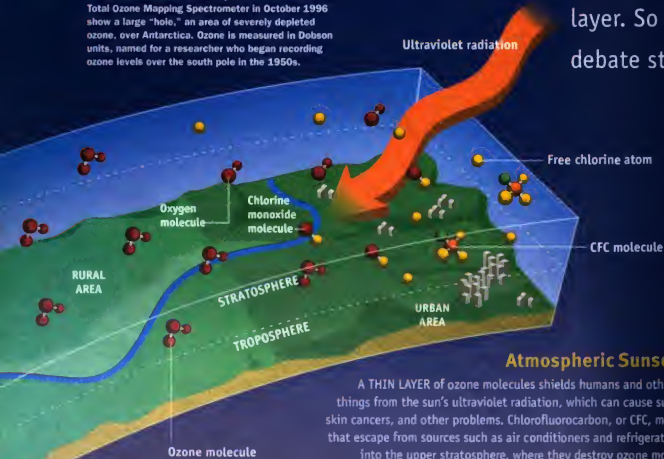
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Attack on OZONE SCIENCE

Nobel Prize-caliber scientists concluded years ago that CFCs damage the ozone layer. So why is the debate still raging?



Ozone measurements taken by NASA's satellite-borne Total Ozone Mapping Spectrometer in October 1996 show a large "hole," an area of severely depleted ozone, over Antarctica. Ozone is measured in Dobson units, named for a researcher who began recording ozone levels over the south pole in the 1950s.



Atmospheric Sunscreen

A THIN LAYER of ozone molecules shields humans and other living things from the sun's ultraviolet radiation, which can cause sunburns, skin cancers, and other problems. Chlorofluorocarbon, or CFC, molecules that escape from sources such as air conditioners and refrigerators drift into the upper stratosphere, where they destroy ozone molecules.

WHEN THE WINNERS of the Nobel Prize for Chemistry appeared at the flower-filled Stockholm Concert Hall in December 1995 to receive their awards from King Carl XVI Gustaf, they were met by pickets. Why?

Because two of the three Nobelists, F. Sherwood Rowland and Mario Molina, were being rewarded for their pioneering work on the chemistry of ozone depletion. Their research showed that compounds called chlorofluorocarbons, or CFCs—once widely used

Arthur Fisher

as refrigerants and as propellants in spray cans—are responsible for the

progressive thinning of the ozone layer, which shields us from the sun's ultraviolet radiation. The work of Rowland and Molina, along with that of other atmospheric scientists, has led to a worldwide phaseout of CFCs.

The Stockholm pickets were from the Schiller Society, a European group affiliated with 21st Century Science Associates in the United States. The American group is run by supporters of Lyndon Larouche, a convicted felon whose baroque pronouncements have included labeling Queen Elizabeth II as the head of an international drug ring. Outside the Stockholm hall, the pickets distributed

leaflets with quotes from a 1992 book published by 21st Century Science Associates, *The Holes in the Ozone Scare* by Rogelio A. Maduro and Ralf Schauerhammer. Rowland has called the book "a good job of collecting all the bad papers in the field in one place."

Larouche's followers are part of a continuing movement that has come to be known as the ozone backlash. Afforded ostensible respectability by a handful of contrarian scientists, it seeks to deny the environmental threat posed by the thinning of Earth's fragile ozone shield, and to roll back the ban on the chemicals that have contributed to it. The backlash movement has spawned a number of books, ranging from the late Dixie Lee Ray's 1992 *Trashing the Planet* to Gregg Easterbrook's 1995 *A Moment on the Earth*, which dismissed concern over ozone depletion by maintaining that being subjected to increased ultraviolet radiation would be no worse than moving to a different latitude.

The results of the so-called ozone backlash have been felt from coast to coast. The Nobel Prize Committee was criticized by *The Wall Street Journal* and even ridiculed on the editorial page of *The Orange County Register*, despite Rowland and Molina having done their work in that

A CFC molecule drifts into Earth's upper stratosphere.

Ultraviolet radiation

Persistent Destruction

CFC MOLECULES destroy ozone molecules through a series of chemical reactions, leaving behind oxygen molecules that are much less effective at blocking the sun's ultraviolet radiation. Some CFC molecules can persist in the stratosphere for more than a century.

2 Ultraviolet radiation from the sun breaks apart the CFC molecule, releasing a chlorine atom.

Chlorine atom

Ozone (O_3)

3 The chlorine atom strips an oxygen atom from an ozone molecule.

Oxygen (O_2)

Chlorine monoxide (ClO)

6 The freed chlorine atom then attacks additional ozone molecules.

5 A free oxygen atom breaks apart the chlorine monoxide molecule.

4 The chlorine and oxygen atoms combine to form chlorine monoxide, leaving behind an oxygen molecule.

INFOGRAPHICS BY ALEX REARDON

The Cancer Connection

THE UNITED NATIONS Environment Program, the National Cancer Institute, and the Environmental Protection Agency predict that a 1 percent decrease in stratospheric ozone could produce a 3 percent increase in the incidence of nonmelanoma skin cancers. That's because reductions in ozone allow more ultraviolet radiation to reach Earth's surface, where this radiation can induce cancer-causing genetic mutations in human skin cells.

Skin cancers have a long latency period, so it could take 20 years or more for the effects of increased radiation to appear. "One in five Americans will get skin cancer in their lifetime," predicts Dr. Rex A. Amonette, president of the American Academy of Dermatology. An estimated 900,000

Americans will develop nonmelanoma skin cancers this year, according to the American Cancer Society. Non-melanomas (mostly basal and squamous cell carcinomas) are usually curable when detected early enough.

Increased ultraviolet radiation can also cause melanomas, which are far more lethal. Melanoma cases have almost doubled over the past two decades, with 40,300 new cases expected this year and 7,300 deaths. At the present rate—a 6 percent annual increase—the American lifetime risk will reach one in 75 by the year 2000.

A study by the Netherlands Institute of Public Health and the Environment released in early 1997 calculated that controls on ozone-destroying chemicals will have prevented 1.5 million cases of skin cancer in the United States alone by 2100.—A.F.

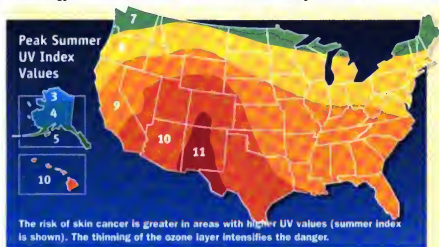
county at the prestigious University of California, Irvine.

In 1995, the U.S. Congress saw an effort to roll back the ban on CFCs. In 1996, there were efforts in the California and Arizona state legislatures to do the same thing. And in 1997, members of the Nevada legislature unsuccessfully attempted to pass a bill allowing CFC manufacturing in that state.

Meanwhile, ozone destruction has reached peak levels in recent years. The infamous ozone hole observed over Antarctica during the Southern Hemisphere's springtime has been opening earlier and lasting longer, and ozone measurements over the Northern Hemisphere dipped to an all-time low last winter.

Maybe it's time for a little refresher on just what we do know about the ozone layer and its meaning for life on Earth. Ozone is a relatively rare blue-tinted gas. Each molecule of this gas consists of three oxygen atoms. (A molecule of the oxygen we breathe has two atoms.)

Although some ozone exists near ground level—it's an ingredient of smog—most appears in the stratosphere, roughly 10 to 50 kilometers above Earth's surface, with the greatest concentration around 20 to 30 kilometers. Even there it is quite rarefied, only a few parts per million. If all the ozone in the atmospheric column were



A Brief History of the Ozone Hole

Follow CFC's path from seemingly inert refrigerant to environmental hazard.

1930
Thomas Midgely, a General Motors chemist, invents CFC-12,



a refrigerant, first of the chlorofluorocarbons.



1945
By this date, most U.S. refrigerators use CFC-12.

1950
CFC production reaches 76 million pounds annually. CFCs

are increasingly used as blowing agents to manufacture Styrofoam.

1960s
Air conditioners using CFCs proliferate in homes and of-

fices. Vehicles eventually account for more CFC consumption than all other uses combined.

1970
Paul Crutzen shows that nitrogen oxides spewed from the proposed supersonic transport could

damage the ozone layer.

1974
Richard Stolarski and Ralph Cicerone



warn that chlorine in the exhaust of the

proposed space shuttle could decompose ozone.

1974
F. Sherwood Rowland and Mario Molina propose that CFCs reaching the stratosphere catalyze the destruction of ozone. They call for

an immediate ban on CFC aerosol propellants, by now accounting for half of CFC use in the United States.

1976
Experiments support the Rowland-Molina theory. The U.S. government bans

CFC propellants starting in 1978.

1985
The international Vienna Convention for the Protection of the Ozone Layer pledges action.

1985
Joseph Farman of the British

compressed to sea-level pressure, it would have a thickness of a mere 3 millimeters.

Nevertheless, this gaseous wraith plays a profoundly important biological role. Without it, life on Earth's surface could not survive. Ozone blocks all wavelengths of the ultraviolet radiation known as UV-C, which is lethal; most wavelengths of UV-B, which is harmful to most life forms; and a few wavelengths of UV-A, which is relatively harmless but can irritate skin.

Each 1 percent decrease in ozone allows a 2 percent increase in the amount of ultraviolet radiation reaching Earth's surface, with a corresponding **increase in the incidence of human skin cancers**, cataracts, and immune system disorders.

Increases in ultraviolet radiation penetrating to Earth's surface are also responsible for damage to animal and plant life, especially to oceanic phytoplankton supporting the aquatic food chains on which fish depend. People worldwide consume 18 percent of their food protein as fish; in Asia the number is 40 percent. So ozone depletion could have a profound effect on an important food source.

No wonder then that worldwide concern resulted when Paul Crutzen (the third winner of the 1995 Nobel Prize for Chemistry) demonstrated in 1970 that the proposed supersonic transport airplane, or SST, could en-

danger the ozone layer by spewing nitrogen oxides into the stratosphere.

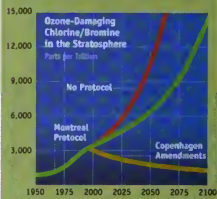
Then in 1974, Richard Stolarski and Ralph Cicerone warned that chlorine in the exhaust of the proposed space shuttle could decompose ozone. A few months later, Rowland and Molina put forth their contention that CFCs would eventually work their way into the stratosphere, break down in reaction to powerful ultraviolet radiation, and release chlorine atoms that would catalyze the destruction of ozone molecules. Rowland and Molina estimated that if CFCs continued to be used at the 1974 rate, the ozone layer would be weakened by 7 to 13 percent by the year 2100. They said an immediate ban on aerosol propellants, which accounted for half the CFCs used in the United States, was essential, even though no physical evidence to substantiate their hypothesis had been found.

But soon afterward, the presence of CFCs and dissociated chlorine atoms in the stratosphere was confirmed by other researchers. By 1976, the evidence was strong enough to persuade the U.S. government to ban the use of CFC propellants as aerosol sprays beginning in 1978. That alone, however, was not enough to reduce the worldwide production of CFCs, which averaged about a million tons a year from 1974 to 1990.

Initially, the chemical industry fiercely attacked the Rowland-Molina

Reducing the Danger

INTERNATIONAL agreement will stem levels of ozone-destroying compounds.



hypothesis—and sometimes the scientists themselves. According to *The Los Angeles Times*, the president of one aerosol-manufacturing company complained that the accusations against CFCs were "orchestrated by the ministry of disinformation of the KGB." Du Pont, the largest manufacturer of CFCs, criticized the research but declared that if evidence showed that CFCs were a threat to health, the company would stop producing them.

The 1985 report of the discovery of the Antarctic ozone hole—an annually occurring severe drop in ozone levels over the south polar region—was a shocker that helped dispel complacency about CFCs. The discovery led to a 1987 international agreement to

1987

The United Nations Montreal Protocol on Substances that Deplete the Ozone Layer is agreed to by 140 countries. It plans to stem

the influx of chlorine and bromine into the stratosphere by freezing CFC and halon consumption in 1989 and cutting it in half by 1998.

1988

The Ozone Trends Panel, established by NASA with the United Nations Environment Program and



the World Meteorological Organization, reports that significant ozone depletion has already occurred over heavily populated areas of the Northern Hemisphere.

1988

Du Pont, the largest manufacturer of CFCs, announces it will halt production as soon as possible.

1992
The Copenhagen Amendments to the Montreal Protocol mandate a halt to the production of CFCs by 1996

in developed countries and by 2010 in undeveloped countries.

1995

A new Vienna Convention, subscribed to by 100 countries, accelerates an earlier timetable for the phaseout of hydrochlorofluorocarbons, or HCFCs, substitutes for CFCs that are

damaging to the ozone layer but less so than CFCs. The convention also agrees on a phaseout of methyl bromide, an agricultural chemical that is 50 times more destructive to ozone than CFCs, but persists in the atmosphere for a shorter time. The U.S. Clean

Air Act calls for a halt to methyl bromide production in 2001.

1996

NOAA scientist D.J. Hofmann predicts that, barring any noncompliance with the Montreal Protocol, the first signs of ozone hole "healing" will be detectable early in the 21st century.



Antarctic Survey reports that for three consecutive years, major ozone losses have occurred over Halley Bay—creating the notorious ozone hole. The discovery spurs action worldwide.



Ocean Life at Risk

THE WORLD'S PEOPLES derive 18 percent of their food protein from fish. Now there are signs that this critical nutrient source could be endangered by ultraviolet radiation penetrating Earth's ozone layer.

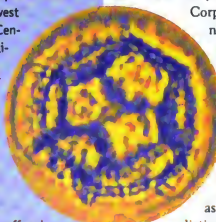
Ultraviolet radiation can impair the production of phytoplankton, microscopic organisms at the base of the aquatic food chain. Biological oceanographers Ray C. Smith and Karen Black of the University of California, Santa Barbara, followed the Antarctic ozone hole's effect on phytoplankton from the late 1980s until 1993. Even on the fringes of a mild ozone hole, productivity declined by 6 to 15 percent.

Last February, biologists from Northeastern University in Boston and the University of Texas reported that increased ultraviolet radiation during the opening of the Antarctic ozone hole damages the DNA of the eggs and larvae of icefish.

However, the effects of ultraviolet radiation can vary dramatically by species. A team led by Russell Vetter of the National Oceanic and Atmospheric Administration's Southwest Fisheries Science Center in La Jolla, Cali-

Ultraviolet radiation harms phytoplankton such as this, which form the base of the ocean food chain.

fornia, studied UV effects on DNA in three species. The northern anchovy suffered the most damage, the California halibut about half of that, and the white sea bass less than one-tenth. "Are we shifting the playing field by reducing ozone and increasing ultraviolet levels?" Vetter asks. "Are we favoring animals who are more resistant? We certainly are."—A.F.



reduce CFC consumption, which was followed five years later by amendments that mandated a halt to CFC production in developed countries by 1996.

Without the sterner controls on CFC production, ozone-damaging chlorine and bromine levels would have continued to rise steeply until 2100 and beyond. That was the conclusion of the World Meteorological Organization's 1994 Scientific Assessment of Ozone Depletion, the most comprehensive and authoritative statement to date on the ozone question, prepared with input from NASA, the National Oceanic and Atmospheric Administration, and the United Nations Environment Program. It is the product of 295 scientists from both developed and developing countries. Therefore, it represents an overwhelming consensus of the world's scientists about the severity of the threat to the ozone layer.

Making exact forecasts of declining ozone levels is difficult, because computer models must account for the variability of cloud cover. Cloud calculations, however, have been clarified with a new satellite-mapping technique developed by Dan Lubin, a research physicist at the California Space Institute in La Jolla, California; and Elsa Jensen of SeaSpace

Corp. in San Diego. The new method combines data from NASA's Total Ozone Mapping Spectrometer, which monitored global trends in ozone from 1978 to 1993, with data that measured solar radiation from clouds as part of the Earth Radiation Budget Experiment

from 1985 to 1990. The comparison shows that change in ozone levels is at least as great as variability due to changing cloud cover. The conclusion is that the negative effects of ozone depletion should be observed by the end of the century in many of the world's temperate regions—large parts of continental Europe, North and South America, New Zealand,

Australia, and southern Africa.

The results, says Lubin, "should give the naysayers pause. You can't deny what the best NASA data on cloud cover and ozone, combined with what we know of physics, show—that we're dealing with a potential source of environmental stress." Why then do some continue to insist that the ozone problem has been exaggerated?

"I can't think of a single explanation of why there should be an ozone backlash now," says atmospheric scientist Ralph Cicerone, dean of physical sciences at UC Irvine, and a key player in unraveling the ozone conundrum. "Among all the environmental issues that have come up in the past 15 to 20 years, this is the one where the science is rock solid."

Cicerone suspects that the ozone backlash may be part of a general anti-government hysteria: "Anything the government is involved in can't be trusted." People don't realize, Cicerone says, that government intervention averted a catastrophe. Because CFCs, halons, and other halocarbons are so long-lived, ozone losses will continue for many years, even with a ban on the production. Scientists predict that the ozone layer will not fully recover until the middle of the next century.

"If the ozone-damaging chemicals had not been banned," says Cicerone, "if the world had continued to produce and use CFCs at the increasing rates of the mid-'80s, we would have been in a real pickle now in terms of biological damage."

Another source of the backlash is that people are now paying to substitute other chemicals—which are far more expensive—for CFCs. "People are complaining about price-gouging when they need to retrofit their car air conditioners to accommodate other coolants," Cicerone says.

The high cost of CFC substitutes, \$10 to \$20 a pound, has also inspired a flourishing black market in the banned chemicals. It costs only 50 cents a pound to make CFCs. So CFC factories have sprung up in Russia and China. (Russia, a developing



country where CFC production is now banned, has been out of compliance with international agreements since the beginning of last year.) Patrols on the Mexican and Canadian borders are now on the lookout for cars carrying not just illicit drugs, but canisters of Freon in their trunks.

In fact, according to the Washington-based organization Ozone Action, it can be more profitable to smuggle CFCs into the United States than drugs. Because developing countries like Mexico are allowed to continue producing CFCs for their own use until 2010, factories in these countries can be legal sources of CFCs that then enter black market channels. Ozone Action has dubbed one smuggling operation "the Frio Banditos."

Economic interests are a critical ingredient in the ozone backlash. "There is a serious connection between groups that oppose limiting carbon dioxide emissions and those that dismiss the ozone hole as insignificant," says Cicerone. "A lot of the climate-change backlash—denying that human activity can materially increase global warming—is being orchestrated by people who saw the ozone layer problem, and the establishment of controls on CFCs, as a dangerous precedent they don't want to see repeated. They don't want to see carbon taxes that would reduce the burning of fuels like coal and oil." Last February, more than 2,000 economists of various political stripes, in-

S. Fred Singer (below) dismisses the environmental risks from chlorofluorocarbons, or CFCs. But the vast majority of scientists say CFCs are harmful to the ozone layer. Prominent in the field are (left to right): F. Sherwood Rowland, Ralph Cicerone, and Mario J. Molina.



cluding six Nobel laureates, signed a document calling for carbon taxes as a means to control the emission of carbon dioxide, a powerful greenhouse gas.

One scientist who has taken part in both the ozone and global-warming backlashes is S. Fred Singer, director of the Science and Environmental Policy Project in Fairfax, Virginia. He is an emeritus professor of environmental sciences at the University of Virginia, and the inventor of a satellite-borne ozone sensor, but has done no original research on ozone depletion since the 1970s. When the House Subcommittee on Energy and Environment held hearings in September 1995 on the need for eliminating ozone-depleting chemicals, Singer upheld the minority view that the case against these chemicals was exaggerated, and proposed rolling back the ban on them to the year 2000 instead of 1996. He said that the subcommittee members were being "misled, bamboozled, and otherwise manipulated by the testimony you have just heard," referring to statements by Robert T. Watson and

Daniel L. Albritton, co-chairpersons of the World Meteorological Organization's International Assessment

panel. Watson and Albritton were paired against Singer and another contrarian, astrophysicist Sallie Baliunas, at the subcommittee hearings.

Testifying at the hearings, Republican Congressman Tom DeLay of Texas, who had previously introduced legislation to cancel the phaseout and relevant provisions of the Clean Air Act, said, "I believe that the science underlying the ban on CFCs and the connection between health and ozone depletion is debatable." Republican Congressman John T. Doolittle of California vowed to introduce legislation to delay the ban until 2000, "so that more research could be performed on the link between ozone depletion and CFCs." Both said they based their reservations on Singer's work.

When DeLay was asked why he believed Singer rather than the hundreds of scientists who collaborated on the World Meteorological Organization's Scientific Assessment, he answered that he had not seen it. "My assessment is from reading people like Fred Singer," he said.



Science Answers the Ozone Critics

Here are some of the most frequently raised objections to ozone concerns, and the scientific responses to them:

Chlorofluorocarbons are much heavier than air, so they can't rise to the stratosphere.

In a refrigerator or other enclosed space, CFCs do collect at the bottom. But the atmosphere is dynamic; its gases are constantly mixed by the wind-driven motion of large air masses that distribute light and heavy molecules equally rapidly. Thousands of measurements have proven that CFCs are present in the stratosphere.

Volcanic eruptions, not CFCs, are the most important source of chlorine in the stratosphere.

Volcanoes emit hydrochloric acid, which is soluble in water. The acid dissolves in volcanic steam, and rains out long before it gets to the stratosphere. CFCs are not water-soluble. One of the worst backlash bloopers appears in *Trashing the Planet*, by the late Dixie Lee Ray and Lou Guzzo. They confused a theory about the eruption of California's Long Valley Caldera 700,000 years ago with the 1976 eruption of Mount St. Augustine in Alaska, which led them to the outrageous statement that Augustine had belched 289 billion kilograms of hydrochloric acid, "50 times more chlorine than an entire year's production of CFCs." Rush Limbaugh later applied the inaccurate figures to the eruption of Mount Pinatubo.

How could the "ozone hole" that appears over Antarctica annually have been discovered in 1956 and 1957—long before CFCs were widely used?

Researcher Gordon Dobson did indeed measure ozone over Antarctica in 1956. However, he discovered not the ozone hole, but a meteorological phenomenon now called the Antarctic polar vortex, which prevents ozone-rich air from the temperate latitudes from sweeping into the polar region until about mid-November. The ozone levels Dobson measured were much higher than those measured when the ozone hole was actually discovered in the early 1980s by Joseph Farman and his colleagues of the British Antarctic Survey.

If the ozone shield is being depleted, why isn't more ultraviolet radiation being detected on Earth?

It is. With a 50 to 60 percent decrease in ozone measured at Antarctica's Palmer Station in late October 1993, UV-B rays were at a skin-damaging level, more intense than the UV-B measured in San Diego, California, at any time during the whole year. The intensity of sunshine reaching San Diego is normally far higher than near the pole, because the ultraviolet light received at any given point on Earth's surface depends in part on the sun's position above the horizon. Measurements taken in Toronto and at various sites in Europe also show a correlation between falling ozone and rising ultraviolet radiation.—A.F.

Today, Singer maintains that "the concern over the ozone hole is overdone. Certainly there is no health concern that should be raised here. There's no global threat it imposes. My view is that CFCs probably should be controlled. I don't like to see any uncontrolled human influences on the atmosphere that we're not sure about. But CFCs are not the most important chemical in the world. I don't see any urgency in controlling them, and I'm much opposed to speeding up the phaseout of production. Chlorine may not be the most important ozone depleter. It's not true that the chemistry of ozone depletion has been completely worked out. There is much to be resolved," Singer says.

The fact remains that few scientists agree with Singer. So how is it that a tiny minority of scientists has managed to keep alive the ozone debate? Says Steven Schneider, a senior fellow at the Institute for International Studies at Stanford University and no stranger to environmental controversies: "The tactic of arranging what seems to be an even-handed presentation, whether in a courtroom or in a 10-minute-per-side debate or before a Congressional committee, can be very effective in getting equal status for a very-low-probability position. And it's used over and over again."

People tend to look at this kind of setup as a Ping-Pong match, U.S. Undersecretary of State for Global Affairs

Tim Wirth has said. "But you have 2,500 scientists—the world leaders—on one side of the Ping-Pong table, and seven scientists on the other side."

In a 1993 address to the American Association for the Advancement of Science, Rowland spoke of the ozone backlash and said he had "a great concern over the role of science in a democracy in which the general population has not enough understanding of science itself, does not entirely trust 'science experts,' and is left with no way to distinguish between the competing claims of apparent experts on both sides of any question." The remedy, he said, "is increasing the basic level of knowledge of science, and communication about science." ♦



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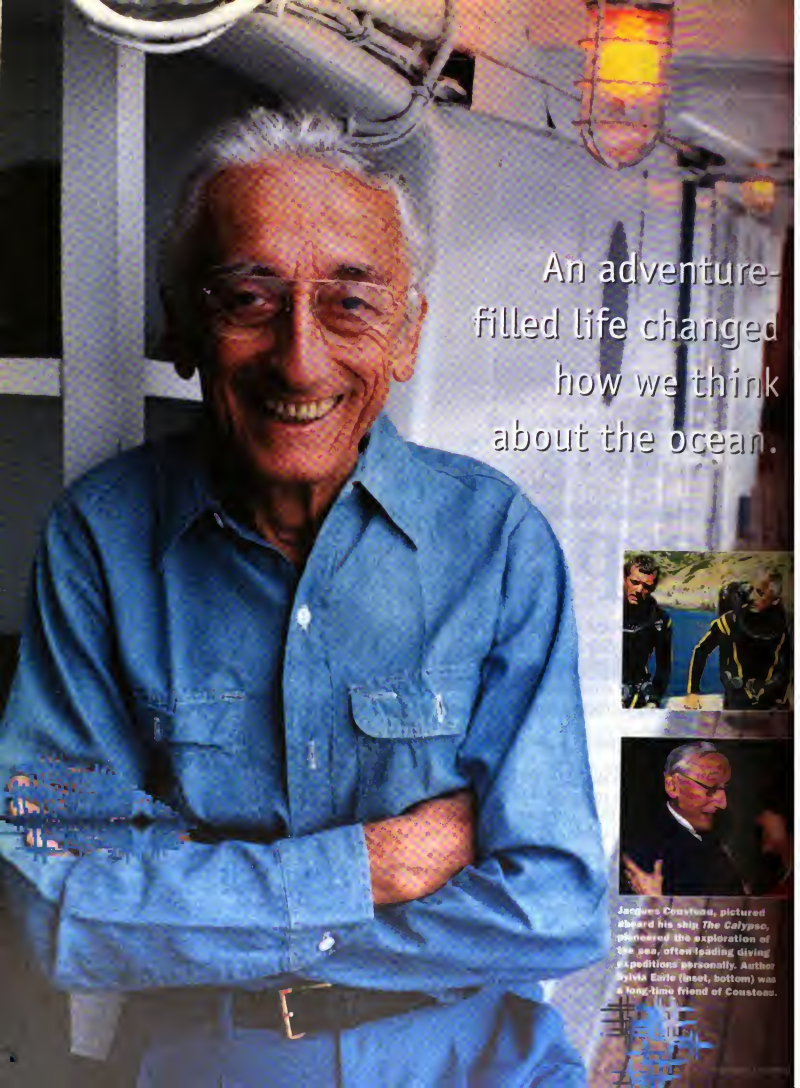
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An adventure-filled life changed
how we think
about the ocean.



Jacques Cousteau, pictured aboard his ship *The Calypso*, pioneered the exploration of the sea, often leading diving expeditions personally. Author Sylvia Earle (inset, bottom) was a long-time friend of Cousteau.

Cousteau Remembered

THE QUINTESSENTIAL man of the sea, Jacques-Ives Cousteau died in Paris on June 26 at the age of 87. His legacy is profound. Scientists respected his creative engineering; engineers lauded his science. Cousteau, who claimed to be neither scientist nor engineer, contributed significantly to both disciplines—and to many more.

Throughout his adventure-filled life, the many-faceted Cousteau defied definition. Yes, he was a captain in the French Navy, and early on, a filmmaker and natural storyteller. Later, he became a renowned ocean explorer, designer of underwater equipment, expedition

leader, author, speaker, entrepreneur, businessman, environmentalist,

By Sylvia Earle

teacher, advisor to world leaders, visionary, dreamer, poet, founder and leader of a vigorous organization (the Cousteau Society), and irrepressible ambassador-at-large for the ocean. But most of all, perhaps, Cousteau was an artist who surveyed the world's potential and drew from its broad palette of possibilities the ingredients needed to create a real life more colorful and heroic than the most outrageous science fiction film character.

All who care about the sea—and even those who don't think much about the ocean one way or another—owe Cousteau a tremendous debt. The knowledge gained as a consequence of his direct contributions, and the magnified impact he had on others, has transformed the way the world thinks about—and behaves regarding—the sea. His stories of encounters with great groupers, sharks, and enchantingly curious octopuses inspired many—myself included—to go see for ourselves. He dreamed up the concept for the Aqua-Lung, and with a colleague, Emile Gagnan, built the

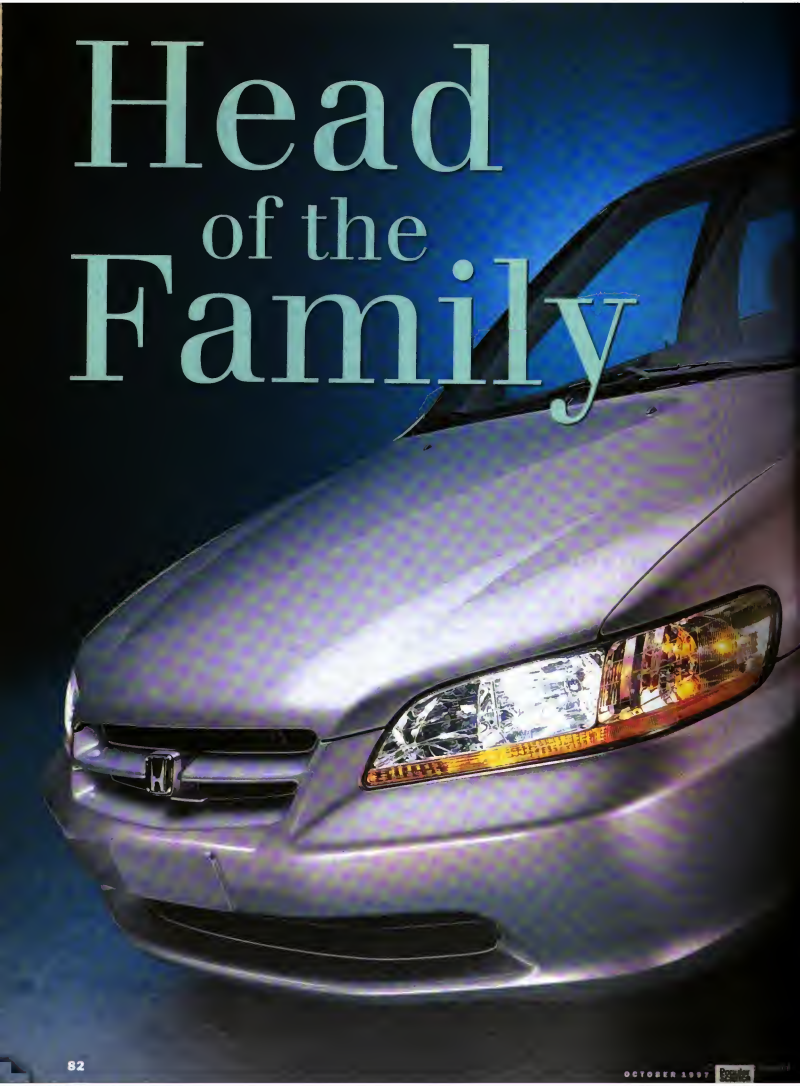
first system in 1943. His exuberant reaction, described in *Silent World*, his first of many books, lured millions into the depths. "I often had visions of flying by extending my arms as wings. Now I flew without wings [into] loops, somersaults, and barrel rolls. I stood upside down on one finger."

Cousteau pioneered ventures in underwater living in the 1960s: sub-sea labs where aquanauts submerged for days or weeks—the aquatic equivalent of Skylab or the space station. His films and television programs won two Academy Awards, three Emmies, and the hearts and minds of viewers worldwide for decades.

Showered with honors, Cousteau remarked recently that he thought his most important accomplishment was to make people aware of—and care about—the ocean. Thanks to him, we who watched and listened were transported into submerged caves, met gentle morays, and were inspected by penguins and squids. We explored shipwrecks, dived with whales, felt the icy bite of Antarctic winds, and cruised in exotic inner-space craft into deep, dark seas flashing with swimming stars. We grew concerned about our growing population and the consequences of overfishing and toxins that threaten the health of the sea, and we were inspired to do something to improve the way things are done.

We grieved with Cousteau when Simone, wife and partner for many years, died and when his son Phillippe was killed in a plane crash. We shared his joy when Jean-Michel, his eldest son, became an explorer and an eloquent spokesman for the sea in his own right. We were happy for the captain when he began a new family with his second wife, Francine. And now that the voice of this bard of the ocean world is silenced, we mourn. ♦

Head of the Family

A close-up, low-angle shot of the front of a silver Honda Civic. The car's headlight is illuminated, casting a warm glow. The Honda emblem is visible on the front grille. The background is a dark, deep blue, suggesting a night sky or a studio backdrop.



Among four-door sedans,
the Honda Accord is
tough to beat.

CHEVROLET MALIBU LS

FORD TAURUS SE

HONDA ACCORD EX

TOYOTA CAMRY LE

WE DREAM OF CRUISING Route 66 in a Corvette or crossing the Rubicon in a Jeep. When the time comes to write the

By Don Sherman

check, however, most of us shelve

our fantasies and select a practical family sedan. But swapping dreams for common sense isn't all that painful, because fresh technology keeps four-door sedans enticing. Every year, automobile manufacturers unveil improvements in safety, comfort, and efficiency.

In 1996, Ford's Taurus retained its title as class standard with its avant-garde styling and crisp handling ["Family Sedans," April '96]. This year, Toyota has refurbished its Camry and Chevrolet has dusted off an old nameplate for a new Malibu. Honda is debuting a sixth-generation Accord for 1998. To see which of these family sedans has evolved most successfully, we've gathered

PHOTOGRAPHED BY JOHN B. CARNETT



The Accord's beveled nose lends sophistication. Color-keyed body-structure reinforcements improve front crashworthiness (orange), side-impact resistance (yellow), quietness (blue), and overall rigidity (red).

the foursome for this test. The Taurus and Accord were available in 1998 models; no significant '98 changes are expected in the '97 Camry and Malibu we tested.

All five Honda redesigns have upped the ante in performance, comfort, convenience, and safety. Like its predecessors, the new Accord sparkles with clever improvements. Most no-

bins; its pushrod V6 engine is an updated version of a powerplant that was introduced in 1980. The Taurus borrowed key floorpan components from its immediate predecessor. The fourth-generation Camry is a shrewd refinement of the third-generation design.

The 1998 Accord, however, is 82 percent new, encompassing

front of the car) in one tidy unit.

The Camry, Malibu, and Taurus all use struts at both ends of their chassis, with acceptable results. But because struts are inherently high in friction, Honda engineers have continued to take an alternate path. As does the previous model, the new Accord has unequal-length control arms and long, curved steering knuckles to support and guide the front wheels. The rear suspension is a new multilink design: five locating links position each rear wheel. The benefits are low fric-



Chevrolet's new Malibu adopts a high, rounded roofline (left), a design feature that yields substantial headroom for front-seat passengers. The reflector-style headlamps (above) are among the few styling details that provide visual relief from the smooth, rounded envelope. The low-priced V6 option keeps the Malibu's price down, even when fully equipped.



table is the roomier interior, which brings the Accord to parity with the other test vehicles, each of which provides about 100 cubic feet of passenger space and roughly 15 cubic feet of trunk room.

The new Accord is a textbook illustration of independent thinking. To make a comparison, we considered the extent of old parts carried over to save cost. The price-fighter Malibu is for all intents a car created from parts

such changes as a clean-sheet body structure, an all-new interior, a choice between two new engines and two types of automatic transmissions, an entirely different rear suspension, and a revised front suspension.

The most popular approach to suspension design is the MacPherson strut, an ingenious spring-and-shock mechanism that combines up-and-down flexibility, damping, springing, and even steering (when fitted to the

tion (for a smoother ride) and high stability. To reduce impact harshness, the rear suspension guides the wheels slightly aft as they rise over a bump. Because the five-link layout requires less space, interior designers were able to shift backseat passengers 1.2 inches rearward, so they can stretch their legs.

A firm structure is essential for anchoring not only subframes but all major components. Stiff but light is the objective: That's what delivers a placid ride with predictable handling and optimum performance. Honda engineers have achieved the goal, increas-

ing bending rigidity in the Accord by 69 percent and torsional (twisting) stiffness by 40 percent over its predecessor.

The new Accord also tops the previous generation in withstanding a collision. A ladder-type framework of box-section members is welded with the body to help absorb impact, while preserving interior survival space. Roof pillars are reinforced and doors are girded with tubular beams.

For the most part, Honda is merely catching up with structural improvements the competition made in 1996 and 1997 to improve safety and rigidity. But the Accord is ahead of the pack with at least one feature: small,

enhancements in its four-cylinder powerplants. The Accord's new 2.3-liter I4 betters its predecessor in every measurable category—power, fuel efficiency, noise, weight, even the number of parts. In lieu of the standard dual-overhead cam, Honda uses a single belt-driven cam to open four valves per cylinder by means of roller-tipped rocker arms. Extra cam lobes and an electronically controlled, hydraulically activated system permits the disabling of one intake valve per cylinder at low rpm to induce a swirling motion as the fresh fuel-air mixture enters the cylinder. That swirl facilitates complete combustion, for low

sion vehicle in the Golden State.

To satisfy demand for a smoother and more powerful engine, Honda has engineered a V6 exclusively for the United States. The 3.0-liter piston displacement is carried over from last year's V6, but beyond that, this year's model is considerably changed. The new diecast aluminum cylinder block has a 60-degree bank angle, iron cylinder liners, and cross-bolted main bearing caps. Like the Accord's four-cylin-



The Ford Taurus is facelifted for 1998 but the real news is a major repackaging of trim and optional equipment to improve value in response to competitive pressures. The 200-horsepower DOHC V6 is now optional even in the top SE series.



energy-absorbing tubes made of corrugated aluminum, sandwiched between soft interior trim and the roof rails to diminish the likelihood of serious head injury. This innovation brings the Accord into compliance with a federal requirement for head protection that won't be mandatory until the 1999 model year.

Honda's distinctive tack in improving the family sedan stays on course with the powertrain. Even though other automakers clearly favor V6 engines, Honda continues to implement major

emissions and high fuel economy. Honda calls this exotic system VTEC (a valvetrain timing control system).

The new engine comes in three varieties: a 135-horsepower version for the base DX model (lacking VTEC), 150 hp for LX and EX models, and 148 hp for use with an automatic transmission for models sold in California. According to Honda, the third version is the world's cleanest-burning four-cylinder engine, making the Accord the first mass-produced car to be certified as an ultralow emis-

der engine, the V6's four valves per cylinder are operated with a single-overhead-cam VTEC system. The gain in output over the previous model is a phenomenal 18 percent for both power and torque, achieved without resorting to premium fuel. But customers will probably appreciate the \$1,500 price cut even more.

Past Accords have scored at or near the top of the class in performance, so we were not surprised to find the new model holding its own against tough competitors. Most owners should find the new four-cylinder engine quite adequate for their needs: Even when teamed with an automatic transmission, it races from 0 to 60 in less than 10 seconds. If you don't mind



Made over in the '97 model year, Toyota's Camry has a more formal rear-end treatment (above), and a slightly raised roofline at the rear that increases rear-seat headroom.





HONDA ACCORD EX



TOYOTA CAMRY LE

ACCELERATION				
0-30 mph (sec.)	3.3	3.1	3.0	3.2
0-60 mph (sec.)	8.2	8.8	8.1	8.7
TOP GEAR PASSING				
30-50 mph (sec.)	4.2	3.8	3.9	4.5
50-70 mph (sec.)	4.9	5.3	4.6	5.2
HANDLING				
800-foot slalom (mph)	47.1	46.2	48.5	45.1
Double-lane change (mph)	59.0	57.2	58.2	55.7
60-0 MPH BRAKING				
Cold (ft.)	141	142	135	149
Warm (ft.)	138	141	135	144
Hot (ft.)	147	139	139	155
INTERIOR NOISE				
Idle (dBA)	41	46	42	49
60 mph (dBA)	61	76	62	74
0-60 mph (dBA)	69	64	68	64
EPA MILEAGE				
City/highway (mpg)	20/28	20/29	19/26	19/28
POWERTRAIN				
Engine	SOHC 3.0L V6	DHV 3.1L V6	DOHC 3.0L V6	DOHC 3.0L V6
Valves/cylinder	4	2	4	4
Power (hp @ rpm)	200 @ 5,500	155 @ 5,200	194 @ 5,200	200 @ 5,750
Torque (ft.-lbs. @ rpm)	195 @ 4,700	185 @ 4,000	209 @ 4,400	200 @ 4,500
Transmission	4-speed automatic	4-speed automatic	4-speed automatic	4-speed automatic
CHASSIS				
Front suspension	Ctrl. arms, coil springs	Strut-type, coil springs	Strut-type, coil springs	Strut-type, coil springs
Rear suspension	Multilink, coil springs	Strut-type, coil springs	Strut-type, coil springs	Strut-type, coil springs
Brakes, f/r	Vented disc/disc, power-assisted	Vented disc/drum, power-assisted	Vented disc/disc, power-assisted	Vented disc/drum, power-assisted
ABS	3-channel	4-channel	3-channel	4-channel
DIMENSIONS				
Wheelbase (in.)	106.9	107.0	105.2	108.5
Length (in.)	188.8	190.4	188.5	197.5
Width (in.)	70.3	69.4	70.1	73.0
Height (in.)	56.9	56.4	55.4	55.1
Curb weight (lbs.)	3,075	3,060	3,280	3,428
F/r distribution (%)	61/39	65/35	62/38	64/36
Headroom (f/r in.)	38.5/36.5	39.4/37.6	38.6/37.6	39.2/36.2
Legroom (f/r in.)	42.1/37.9	42.2/38.0	43.5/35.5	42.2/38.9
Shoulder room (f/r in.)	56.9/56.1	55.5/55.3	56.2/56.1	57.4/56.6
Passenger volume (cu. ft.)	98.3	99.9	97.9	101.0
Trunk volume (cu. ft.)	14.1	16.4	14.0	15.8
Fuel tank (gal.)	17.1	15.0	18.5	16.0
SAFETY FEATURES				
Airbags	Dual	Dual	Dual	Dual
Side-impact protection	Yes	Yes	Yes	Yes
Child door locks	Yes	Yes	Yes	Yes
PRICES				
Base price	\$24,000 estimated	\$18,715	\$22,568	\$20,000
Price as tested	\$24,000 estimated	\$18,815	\$25,463	\$23,000
Major options	None	Compact disc player, \$100	Leather trim, \$1,100; moon roof, \$1,000; aluminum wheels, \$435; sound system, \$250; floor mats, \$90; intermittent wipers, \$70	Sunroof, antilock brakes, keyless entry, leather-wrapped steering wheel

CHEVROLET MALIBU LS



FORD TAURUS SE



shifting for yourself, the 2.3-liter engine clocks the run in 8.8 seconds, an even match with the 3.1-liter V6 Malibu and just a tick slower than the 3.0-liter V6-powered Taurus. The V6 Accord trims another few tenths with a 0-to-60 run of 8.2 seconds, a tenth slower than the smooth, quick Camry.

Antilock brakes are standard in the attractively priced Malibu and optional in the other three sedans. The Camry sets the pace in braking, winning two of the tests outright and sharing first place with the Malibu in the third.

Each entry finds its own slot in over-the-road behavior. The Malibu's combination of simple suspension hardware and a rigid-mounted front cradle reacts stiff-leggedly to expansion joints and chuck holes in the road. When it's hustled into a bend with a decreasing radius, however, there's insufficient damping to keep body motions calm and collected. In fact, pavement imperfections jar the Taurus enough to compromise ride comfort, even with an additional layer of rubber isolation up front. Ford's family hauler delivers a better feel for the road than the other cars in this test. The Accord feels light and lively on its feet, never argumentative with less-than-perfect road surfaces.

Toyota's Camry is effectively a Lexus without the sting of steep monthly payments. While it never aspires to sport sedan status, it also never shows a rough edge or a cranky disposition, performing with quiet, consummate grace.

Choosing a favorite from this field isn't difficult if you establish priorities. The Malibu's bargain-basement price is a sure bet if maximum elbow-room for the dollar is your quest. Distinctive exterior and interior design makes the Taurus a sensible choice for those uncomfortable blending in with the family-sedan set. The Camry offers first-class accommodations at a premium price. The Accord offers well-rounded competence, a charming personality, and a high-value price tag. This shrewd combination of assets makes the Accord the best deal going in family sedans. ♦

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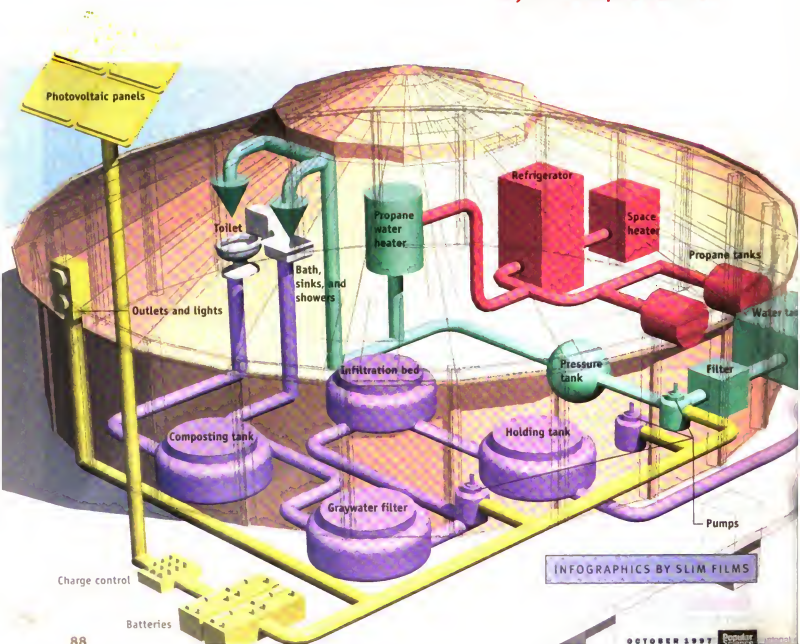


CRAFTSMAN

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The ECO Home

By Christopher Miller



Living without connections to electric or water utilities has never been so comfortable.

MANDY WEST IS ADAMANT: "I require independence, but I need to be comfortable," explains the Californian contracts manager. That's why she was drawn to an Ecolodge. "It was rustic and basic, but all the amenities were there," she explains.

Developed by Geo-Lite Systems in San Diego, California, Ecolodges are at home in remote locations. They are self-contained, requiring no municipal service connections for electricity, sewage, gas, or water. But don't expect to make do with a sleeping bag or outhouse: The cylindrical dwellings have ample room for a queen-size bed and come standard with a full bathroom and kitchenette.



All-wood panels, panels with windows, and panels with doors let you customize the Ecolodge; replace a panel, and you can create a different view.

Ecolodges need no foundation. A small footing supports each 320- to 720-square-foot lodge. The structure sits on a rectangular, lightweight steel platform, which shelters the batteries that store energy produced by the solar cells, as well as tanks for sewage, drinking water, composting filters, and propane fuel.

All parts of the Ecolodge either bolt, screw, or snap together. Using only a power screwdriver and a hammer, two people can erect an Ecolodge in two days. The compartmentalized design also makes relocating these homes easy.

"The solid panelized walls interlock," explains Geo-Lite design director Bob Galbreath. "They're steel-framed, with wood paneling and insulation in the center." The 4- by 7-foot sections come in three types: a door, panels that are all wood, or panels that are half window, half wood. The panels themselves are made from recycled plastic lumber.

To customize each Ecolodge, the panels can be used in any combination. "Increasing the number of panels enlarges the unit," adds Galbreath. And if you desire a new view, you merely replace a panel.

Supported by tubular steel rafters, the translucent polyvinyl fabric roof is secured to the steel-framed walls by industrial Velcro hook-and-loop fasteners. "The light comes in, so you have the feeling of wide-open spaciousness," West adds. A 6-foot-wide deck extends from the glass-door entrance of the Ecolodge, and there's room enough to relax and



The translucent polyvinyl roof makes Ecolodge interiors seem spacious. A dining-room table and love seat fit comfortably.

Irrigation

Self-Sufficiency

INSTEAD OF BEING CONNECTED to outside utilities, each Ecolodge has its own water and power: Stowed under the house's 36-inch support platform are water tanks, a water-recycling system, and piping for a composting toilet. Photovoltaic cells power lights, outlets, and water pumps. After water is used in the shower or a sink, it goes into a graywater-filtration system, making it useful for irrigation.

unwind on a chair and footstool.

Photovoltaic cells mounted outside the Ecologde power most of the electrical equipment. The panels generate 100 watts of electricity; batteries store the energy. "The batteries can go for five days without sun before power is shut off," Galbreath says. The system has enough juice to keep lights and water pumps working, but isn't designed to handle energy-hungry conveniences like a dishwasher, TV, or VCR. Small, 40-pound propane tanks power the refrigerator and the optional space heater.

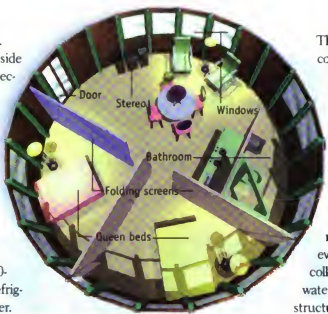
Using energy from propane on-site is more energy efficient, say the Ecologde designers, because a percentage of all electricity delivered over a grid is inevitably lost during transmission.

Independent Living

EcoloDGE MAY BE the latest example, but it's hardly the first home design that lets owners live comfortably without hookups to power utilities: Today, there are some 100,000 such U.S. homes—double the total from five years ago, says the National Energy Information Institute of Washington, D.C. Some efforts have relied on the familiar, such as using energy-efficient design, while others look to technology's edge for "off-the-grid" living.

Earthships, for instance, have high-mass walls that take advantage of temperature swings in the arid Southwest. First conceived in the early 1960s at MIT, Earthships have thick walls formed from mud, discarded tires, and aluminum cans. The walls slowly transmit heat from outdoors to the interior, to maintain a year-round temperature of 60° to 70°F without requiring a heating or cooling system. Photovoltaic cells provide power for most appliances.

Plug Power, a subsidiary of the Edison Development Corp. in Detroit, and Latham, New York-based Mechanical Technology bring power to the people another way: fuel cells. By 2001, the team aims to install 10,000 fuel cells in homes. Fuel cells produce electricity through the electrochemical reaction of oxygen and hydrogen, which would be derived from natural gas.—C.M.



The largest Ecologde model is 730 square feet—large enough for two bedrooms with queen-size beds, plus a communal living area and bath.



No (electric) hang-ups: Earthships conserve energy with thick walls of tires, mud, and aluminum cans; solar power does the rest.

The noise level inside the lodge is comparable to being inside a tent.

"I could hear the crickets at night," West says. Unlike a tent, Ecologde has an electric fan at the ceiling's apex to circulate air. And except for a radio plugged into one electrical outlet, crickets and cicadas rule the airwaves at night.

Ecologdes require an external source of potable water. However, Geo-Lite is designing a rain-collection system that will provide water for irrigation and the bath. The structure's conical roof will capture rainwater, which will then be shunted to a storage tank under the house. Stored water will then be distributed to the bathroom and the kitchenette. A propane water heater produces hot water. "I had running water and toilet facilities in a remote area," West says.

After freshwater is used in the shower, sinks, and kitchen, it becomes graywater—another resource in an Ecologde. A mesh fabric filter and a transpiration bed work together to clean graywater, so it can be reused for flushing the toilet and irrigating nonfood plants. The first, a sock-type filter, removes larger particles such as hair and bits of food; the second uses what amounts to a planter box, with a graduated bed of stones, to remove bacteria. Plant roots draw up the graywater and the leaves transpire 80 percent of the moisture into the air; the remaining effluent provides water for flushing the composting toilet. No other septic systems are needed.

Perhaps the biggest surprise for West was the composting toilet: "It seemed like a traditional one." The bathroom's composting toilet looks like a regular toilet, though smaller. To compost the sewage, an Ecologde dweller would have to deposit a bulking material, either peat moss or coarse sawdust, every two days. A handful of the material is needed for each person using the toilet. The only other maintenance: "Every three months, a person will empty a shoebox-worth, per person using the toilet, of composted material," says Galbreath, "It looks like potting soil, flaky and powdery; it tends to be a darker blackish-brown color, like ashes in a fireplace."

Ecologdes come in three sizes: 320, 500, and 730 square feet. The Bonaire model, which is the largest Ecologde available, costs \$55,950. It has two bedrooms in addition to a common room, bathroom, and kitchenette. The smallest version, the Nihoa, sells for \$16,950 and is a bit more spartan—it's essentially a common room with a bathroom and kitchenette. There's an optional fireplace (\$650), a remedy for chilly mountain nights. But be it ever so humble, there's no place like this eco-home. ➤

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5-YEAR

New Car

America keeps on truckin'
into the next century.

Preview

TO WEAN US AWAY from gasoline, automotive technology of the 21st century will almost certainly focus on alternative-fuel vehicles. Environmental concerns and depletion of global petroleum supplies will force the development of propulsion powered by electricity, natural

By **Tony Swan**

gas, methanol, hydrogen, and various hybrid systems to keep cars operating when the oil wells start sucking sand.

But that era still lies somewhere in the murky distance.

The immediate future isn't murky at all, however. We'll charge merrily across the millennial frontier in a collection of vehicles that are the antithesis of those distant objectives. Specifically, trucks.

Minivans, pickups, and sport-utility vehicles continue to constitute an ever higher percentage of North Amer-

ica's vehicles. More than half of the new vehicles produced by the Ford Motor Company for North America are trucks of one sort or another, and industry forecasters expect trucks to account for more than half of new vehicle sales in the year 2000.

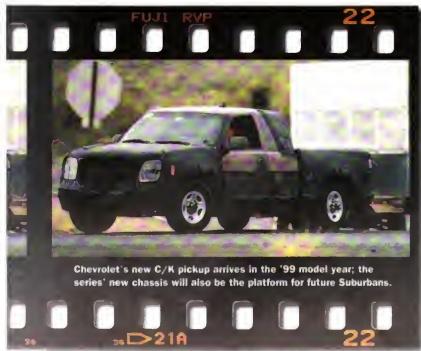
Sport-utilities continue to power this phenomenon. More than 2 million SUVs rolled out of U.S. showrooms in '96, accounting for 14.2 percent of the total market, and as long as America continues to have the cheapest fuel on Earth—our prices are less than half what Europeans pay—this trend will continue.

Manufacturers are steering product development toward vehicles that embody that rugged, go-anywhere image we all seem to love. Companies already firmly entrenched in the SUV market—Ford, General Motors, and Chrysler—continue to expand their range of offerings. Companies that lack sport-utilities—Audi, Volkswagen, and Volvo, for example—are scrambling to claim at least some share of this market. Two redesigned pickups and a new minivan from Toyota complete the picture of light truck domination for 1998.

Of course, not all the '98 news will be truck-oriented. Some highlights follow.

Chrysler Although the macho SUV has seduced a multitude of buyers, we still respond to sheer beauty, and that word certainly applies to the redesigned LH sedans—Chrysler Concorde, Dodge Intrepid, Eagle Vision, and Chrysler LH5, the last two due in mid-'98 as '99 models. Stunning is not too strong a word for this foursome.

General Motors Cadillac's redesigned Seville is GM's headliner for '98. Although this car's revised exterior is evolutionary, extensive refinements to the chassis and powertrain promise to put the Seville on more equal footing with its



Chevrolet's new C/K pickup arrives in the '99 model year; the series' new chassis will also be the platform for future Suburbans.

prestigious rear-wheel-drive competitors.

GM's future lies in consolidating its mainstream vehicles on a worldwide platform, keeping chassis and engines basic while stressing styling variety to differentiate between models.

Ford Already on sale, the Expedition-based '98 Lincoln Navigator SUV is Ford's biggest news. Like GM, Ford is planning more "world cars" that rely on basic chassis with styling refinements.

Imports While the Chrysler Concorde and Dodge Intrepid are likely to sweep the '98 styling awards, Honda's all-new Accord lineup, which includes a distinctive new coupe, looks like a strong contender for car-of-the-year honors ["Head of the Family," this issue].

Toyota, meanwhile, offers a cautious

BRUNO MAGLI AND COMPANY



Porsche's 911 gets a body that combines some of the details of the old 911 and the 928. The car remains rear-drive, but it will get a new water-cooled "boxer" engine.



but comprehensive redesign of its Corolla compact, along with an all-new front-drive minivan—the Sienna—based on the Camry platform. At Lexus, the redesigned GS sedans will finally live up to their sport sedan promise, particularly the GS 400, propelled by a 300-horsepower 4.0-liter V8 with an ingenious new continuously variable cam timing system.

Other '98 newcomers among the Asian import name-

plates: a subtly redesigned and refined Nissan Altima, plus the Frontier, Nissan's first new compact pickup update in seven years; a redesigned Mazda 626; the Subaru Forester, a small all-wheel-drive sport-utility based on the subcompact Impreza; and the U.S. debut of Korean carmaker Daewoo.

Among the Europeans, the major news lies outside the SUV realm. Porsche is set to take the wraps off the long-awaited replacement for its ever-green 911 sports car. Code-named 996, the first total redesign since 1965, the 911 replacement will share a number of components with Porsche's mid-engined Boxster.

Volkswagen and Audi will make strong bids to improve their U.S. fortunes, the former with an all-new—and significantly bigger—Passat sedan and wagon, the latter with a redesigned A6 sedan. VW will also launch its much-anticipated

Beetle revival. The shape will be familiar to lovers of the legendary bug, but the front-drive underpinnings are borrowed from the hatchback Golf family.

In addition to the M-Class SUV, Mercedes will announce a C-Class sedan update. Volvo's sexy C70 coupe will finally make its U.S. debut.

At BMW, look for the possible arrival of the Z5, a peculiar two-door sport wagon version of the Z3 roadster. Jaguar, meanwhile, will install its superb new 4.0-liter V8 engine in its XK sedans. ▶

ACURA

Integra	195-hp Type R joins lineup; facelift due	Evolutionary styling update, new alphanumeric name	
CL	More powerful 4-cylinder engine for 2.2CL	Cosmetic update, powertrain upgrades	
TL	Redesign based on new Honda Accord platform	Interim freshening due	2002 New NSX due
RL	Sport edition joins lineup for 1998		
NSX	290-hp V6, 6-speed transmission, chassis upgrades added mid-'97		
SLX	Modest styling updates, power increase for Isuzu Trooper clone	All-new Accord-based SUV replaces rebadged Trooper	

ASTON MARTIN

DB7	Shared platform with Vignale replacement		
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AUDI

A4	190-hp 2.8-liter DOHC 30-valve V6 replaces 12-valve version		2002 New SUV based on A6
A6/S6	Major redesign; new 200-hp 30-valve V6	Coupe version joins A6 model line	
A8	300-hp luxury sport coupe expected	A8 replacement due	
TT/TS	A4-based 2-seat coupe and roadster due		

BENTLEY

Brooklands/Continental	4.0-liter BMW V8 replaces OHV V8		
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BMW

Z3	Square-backed Z5 sport wagon; high-performance M roadster due	Sport coupe	2002 New SUV hybrid
3 Series	All-new 3 Series coupe and sedan		
5 Series			
7 Series	Head-protective airbags added for front passengers		
8 Series		New 8 Series	

BUICK

Skyline	Skyline revival expected based on new Olds Alero platform		2002 Buick minivan considered
Regal	Redesign		
Century			
LeSabre	All-new LeSabre, based on Riviera platform		2002 Rear-drive revival, possible
Park Avenue			
Riviera	Cosmetic freshening expected for flagship coupe		

CADILLAC

Catera		U.S.-built replacement model; possible switch to front-drive platform	
Eldorado	Major redesign for		



The '98 Seville gets a new engine.

Seville	Modest styling change, major chassis overhaul for Seville, STS	luxury sport coupe follows Seville intro	
DeVille		Redesign incorporates Aurora/Riviera chassis	

CHEVROLET

Netro	Geo brand name dropped; facelift due	Redesign due, based on Opel Corsa platform	
Cavalier		Interim facelift due	
Prizm	Major redesign for Corolla-based compact; new engine		
Malibu		Interim facelift due	
Lumina		Redesign due with new name	
Monte Carlo		All-new coupe planned with smaller Malibu platform	
Camaro	Cosmetic updates; 300-hp LS-1 V8	325-hp high-performance edition planned	Complete redesign expected, independent rear suspension
Corvette	Convertible model joins lineup	Low-cost model	
Venture			
Astro			
Tracker	Geo nameplate dropped	Redesign based on Suzuki Sidekick	
Blazer	Modest styling updates		
Tahoe			Redesign based on new C/K full-size pickups
Suburban			
S-Series Pickup			
C/K Pickup		All-new 1500 and 2500 full-size trucks due mid-'98	New heavy-duty 3500 series completes new C/K lineup

CHRYSLER

Cirrus		Facelift due, new V6 engine option	
Sebring		Facelift due, new V6 engine option	
Concorde	Major redesign, all-new V6 engine family, leads new LH sedan rollout		
LHS		All-new LHS due in mid-'98; special 300 model expected	
Town & Country		Cosmetic updates	New minivan



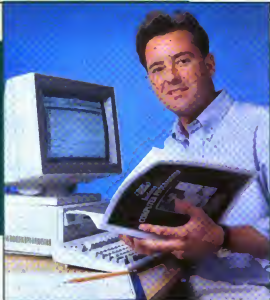
The '98 Concorde's styling is sleek.

DAEWOO

Lanos		Honda Civic-size compact sedan	
Nubira		New Ford Contour-size sedan	
Leganza	Korean carmaker enters U.S. market with midsize sedan		
Minivan			New V6-powered minivan expands model range

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Model	1998	1999	2000	2001
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DODGE

Neon	Budget sport version offered with ACR suspension package		New Neon	
Status		Facelift due, new V6 engine option		
Avenger		Facelift due, new V6 engine option		
Intrepid	All-new Intrepid bows with new family of V6 engines			
Viper				
Caravan		Interior freshening		
Ram Van				
Durango	New midsize SUV based on Dakota pickup; two V8 engine options			
Dakota	4-door Club Cab option			
Ram Pickup	4-door Club Cab option			



The Durango is Dodge's new SUV.

EAGLE

Vision	Major redesign due in mid-'98 based on new Chrysler LH			
Talon		Major redesign expected for midyear launch as 2001 model		

FERRARI

F355		New F355 due		
456GT/GTA	Automatic transmission option			
550 Maranello				

FORD

Escort	ZX-2 coupe rounds out lineup	All-new Escort due on new platform	2002 Possible convertible	
Contour	195-hp limited-edition SVT model offered for early '98			
Taurus	Front-end freshening, detail updates			
Crown Victoria	Modest redesign due for late '97 launch			
Mustang	Cosmetic update		Contour-based replacement model	
Windstar		Major redesign due, incorporating fourth door option		
Econoline Van/Club Wagon		Heavy-duty E-350 gets F-350 pickup updates		
Niue-SUV		All-new small SUV planned, based on Mazda 626 platform		
Explorer		Limited edition V8-powered SVT Taurus expected		
Expedition		Suburban-size variant based on F-350 pickup; V10 engine option		
Ranger Pickup	All-new Ranger, based on Explorer platform	Minor redesign		
F-Series Pickup		New heavy-duty F-350 completes F-Series makeover		

Model	1998	1999	2000	2001
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GMC TRUCK

Jimmy	Special Envoy model offered; new name could replace Jimmy			
Yukon	Upscale Denali model debuts		Redesign due based on new C/K pickup truck chassis	
Sonoma Pickup	Dual airbags, revised interior			
C/K Pickup		All-new 1500 and 2500 series pickups due	New 3500 series completes new C/K model range	

HONDA

Civic/FX	Civic-based EV electric offered for fleet evaluation		Redesign due; new 1.8-liter 4-cyl. engine	
Accord	All-new Accord sedan, coupe; new 200-hp V6 engine option			2002 Accord redesign
Del Sol		All-new SSM sports car due as del Sol replacement		2002 All-new Prelude
Prelude			Cosmetic updates	
Odyssey			New V6-powered Accord-based minivan planned	
CR-V	5-speed manual trans offered			CRV redesign
Passport	Redesign due based on new Isuzu Rodeo		All-new Accord-based SUV planned	



The '98 Accord is more spacious inside.

HYUNDAI

Accent			Styling update, powertrain refinements	
Elantra		Minor facelift due		
Sonata	Powertrain, suspension updates for midsize sedan family			SUV launch
Tiburon		Possible convertible model		
Minivan			Sonata-based minivan expected	

INFINITI

Q20		Redesign planned, extended wheelbase, expanded interior		
Q30		Modestly updated new model due, based on Nissan Maxima		
Q30	Dropped for '98	Possible Maxima-based luxury sport coupe		
Q45		Interim facelift		
QX4				2002 Q45 redesign
				Cosmetic updates, increased power; due mid-2000

ISUZU

Oasis		Final year for Honda Odyssey-based minivan	Possible clone of new Honda Accord-based minivan	
Amigo		Softtop SUV due to return as midsize entry based on Rodeo		

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Rodeo	Major redesign for midsize SUV	
Trooper	Cosmetic updates, increased V6 power	2002
Hombre Pickup	Extended cab model joins lineup	New Hombre

JAGUAR

XJ8		
XJ Sedans	XJ8 sedan debuts with 290-hp AJ-V8 engine from XJ6	
X200	New entry-level rear-drive sedan; V6 and V8 engine options	

JEEP

Wrangler	4-door model based on Dakar concept vehicle	New Cherokee
Cherokee		
Grand Cherokee	245-hp 5.9-liter V8 added to engine options	Major redesign due

KIA

Amelia		Kia's version of discontinued Ford Aspire subcompact expected
Sephia	Freshened styling for Korean compact	
Credos	New V6-powered midsize sedan expected in U.S.	
Sportage	2-door convertible added to SUV lineup	

LAMBORGHINI

Diable	600-hp V12 super Double	
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LAND ROVER

Discovery		Mild redesign
Range Rover		Upgrade to BMW 4.0-liter V8 engines likely
4.0 SE/4.6 HSE		
CB40		Possible U.S. intro for new Freelander, compact-size SUV

LEXUS

ES 300	New 225-hp V6 with continuously variable valve timing	Interim cosmetic updates	2002 Major redesign
GS 300/400	All-new sport sedans; 300-hp V70i V8 engine powers new GS 400		
LS 400	New 280-hp V8 with continuously variable valve timing	Major redesign due for model-year 2000	2002 V12 possibly added
SC 300/400	New variable valve timing V8 engine for SC 400	Major redesign due; expanded size, new V70i V8	
RX 300	All-new Camry-based AWD SUV; 225-hp V70i V6 engine		
LX 450	LX 470 replaces LX 450; 4.7-liter V8 replaces inline six		

LINCOLN

X200		New small Lincoln shares rear-drive platform with Jaguar X200	
Continental	Cosmetic and detail updates	Possible all-new replacement based on Taunus/Sable platform	
Town Car	All-new sheetmetal, engineering updates, improved handling		
Mark VIII			
Navigator	Ford Expedition-based luxury SUV debuts as early '98		

LOTUS

Elise	2-seat roadster could join U.S. lineup		
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Esprit New V6 version of midengine supercar

MAZDA

Protege	Styling updates due	New Ford Escort-based replacement due mid-2000	2002 New 626 due mid-1999 Ford plan form
626	Major redesign due for midsize sedan; MX-6 sport coupe discontinued		2002 Upgrade due, new
Millenia		Possible replacement model based on new Ford Mondeo	
MX-5 Miata	Extensive redesign, modest power increase; conventional headlights	Possible coupe version	
MPV		Redesign scheduled; future V6 for rear-drive minivan	
SUV		All-new mini-SUV based on 626 platform	
B-Series Pickup	Ford Ranger-based compact truck		

MERCEDES-BENZ

C-Class	Styling updates, new V6 engine; CLK coupe between C and E lines	CLK convertible	
E-Class		Station wagon planned for E-Class; 350-hp AMG sport edition	
S-Class		Redesigned flagship sedan line due with sportier styling	
SL-Class			Major redesign for senior roadsters, new V8, V8 engines
M-Class	All-new U.S.-built midsize SUV, full-time AWD, V6 engine	V8-powered ML-420 joins lineup	

MERCURY

Tracer		All-new model due, based on new Escort platform	
Mystique			
Sable	Freshened front end, drivetrain updates		
Grand Marquis	Refinements, cosmetic updates		
Cooper	Rear-drive model discontinued	Front-drive replacement uses Ford Mondeo/Contour platform	
Villager		Major redesign includes fourth door option	
Mountaineer	4.0-liter SOHC V6 becomes standard engine; V8 optional		

MINI-BISINI

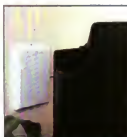
Mirage		Minor cosmetic updates	2002 Mini-B due
Gaia		Extensive redesign; long-awaited V6 engine option added	2002 New all-wheel drive
Diamond			
Eclipse		Cosmetic updates	
3000 GT		Redesign due; possible delays until 2001	
Minivan		New front-drive minivan due for model-year 2000	
Montaro	Modest cosmetic freshening for 1998	New 245-hp direct-injection V6	

NISSAN

Sentra		Extensive redesign, all-new interior and exterior	2002 Redesign due
Altima	Modest exterior redesign, extensive structural upgrades		
Maxima		Major redesign due; Maxima returns to sporty tradition	
200SX		Major redesign for Sentra-based sport coupes	
240SX	Unlikely for 1998	Possible all-new rear-drive replacement could revive 300ZX	

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I'm amazed at the way technology has improved television. Developments in electronic circuitry have resulted in TV sets that have sharper pictures, brilliant colors and clearer sound. From the smallest portables to wide-screen home theater systems, televisions continue to work better and better as optical innovations are introduced. Unfortunately, a television's picture is only as good as the broadcast it's receiving, and even the world's best televisions cannot make up for a weak or distorted signal. Antenna technology has not kept pace with television design, and the rabbit ears from the 1950's are not far removed from what's available today. Well, there's finally been a quantum leap in the design of antennas, and it's the result of two patented components developed by scientists. These improvements are the secret behind Emerson's revolutionary new antennas.

Picture imperfect. Cable subscription solves the problem of getting the signal to your television, but storms and other factors can result in cable outages. If you prefer not to pay the rising monthly fees for cable or live in an area where it's not available, your picture is likely to be weak, undefined and distorted.

One way to improve your reception would be to mount a large antenna on your roof.

Unfortunately, most roof antennas

are not particularly pleasing to

the eye and may even be

prohibited in the area

where you live. Rabbit

ear antennas don't im-

prove your picture to

any great degree and

make your room look

like something from an

earlier decade. Most

antennas need to be aimed

at the source of the broadcast

and require turning me-

chanisms to pick up the signal clearly.

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power of a large antenna in an inconspicuous, low-profile size.

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Recently, a brilliant scientist in Colorado developed an antenna that would maximize reception without being overly conspicuous. Emerson, a leader in electronic technology, has now made this innovation available to the public.

At a lab in Colorado, they developed two patented design improvements that made the Optima antenna possible. First, they created a flexible circuit board with a serpentine antenna, resulting in a large surface area confined to a small space. Second, they developed a technique that converts the copper shielding on the attached cable to an additional signal

receiver that results in an antenna almost 10 feet long. This greatly enhances the antenna's reception power and

Attention mini-dish owners. If you own a mini-dish satellite system, you are aware of the off-air issue and are probably wondering how you can pick up local broadcasts. After all, what good are hundreds of channels if you can't find out who won the local city council race? The Dishmate™ harnesses the same technological innovations as the Optima TV antenna to give you a powerful omnidirectional antenna that is virtually invisible. It is compatible with a variety of systems and is easy to install.



allows you to tune the antenna by simply moving the cable! The handmade assembly is encased in aircraft-grade plastic and high-density foam. The weather-resistant cover is a neutral white and can be painted to match the color of the house or room. Plus, the omnidirectional design allows you to mount the unit anywhere you please. The Optima's universal design makes it adaptable to any component, and installation is a snap. Simply mount the antenna on a wall inside or outside the house, connect the cable and fasten it in place. Then sit back, relax and enjoy the clearest picture you can get from your television.

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Model	1998	1999	2000	2001
Quest		Redesign due with fourth door option, new V6 engine		
Frontier SUV		New pickup-based mini-SUV expected		
Pathfinder			Powertrain updates expected	New design due
Pickup	Nissan's compact truck gets a name (Frontier) to go with new design	3.3-liter V6 engine option due in mid-1998		

OLDSMOBILE

Achieva		New Alero due as Achieva replacement mid-'98	Minor freshening	
Cutlass				
Intrigue		All-new Northstar V8-based DDH, 24-valve V6 replaces 3800 V6		
Eighty Eight/LSS				2002 Rear drive possible
Aurora		Major redesign due		
Silhouette		Interim freshening		
Bravada		Cosmetic updates, drivetrain revisions		

PLYMOUTH

Neon				2002 Mini-SUV considered
Breeze		Facelift, new V6 engine option		
Prowler	Improved hot rod retrocar reintroduced	5.2-liter V8 engine rumored		
Voyager		Interim freshening		

PONTIAC

Sunfire		Interim facelift expected		
Grand Am		Redesigned Grand Am due for fall introduction		
Grand Prix			Minor redesign due	
Bonneville		All-new design on Aurora platform; new DDH V6 engine		
Firebird	Cosmetic updates, 300-hp LS-1 V8	325-hp Ram Air WS6 Trans Am	All-new Firebird, independent rear suspension	
Trans Sport		Interim freshening		

PORSCHE

Boxster		280-hp 3.0-liter flat-six engine option planned		
911	424-hp 911 Turbo S marks end of 32-year heritage	All-new 996 replaces 911; 296-hp 3.4-liter liquid-cooled flat-six	450-hp turbocharged AWD model rounds out S-model range	

ROLLS-ROYCE

Silver Dawn/Silver Spur				
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SAAB

900		New sport coupe based on convertible		
9000		New Opel Vectra-based 9-5 sedan replaces 9000 series		

SATURN

SL Sedan/Wagon			Major redesign due on new platform	
SC Coupe			New coupe follows redesigned sedan and wagon as 2001 model	
EV1	Marketing expands to Washington, D.C., for EV1 electric			
Innovate		Midsize sedan planned with Opel chassis		

SUBARU

Impreza	Limited edition hot-rod 2.5 RS coupe joins lineup			2002 Redesign due
Legacy		Outback-style sport-utility sedan edition due mid-'98	Major redesign due	

Model	1998	1999	2000	2001
Forester	New AWD small SUV based on subcompact Impreza			

SUZUKI

Swift				Redesign due, based on GM's Opel Corsa platform
Esteem	New station wagon model expands lineup			
Sidekick		Major redesign for small SUV; V6 engine option expected		

TOYOTA

Tercel				All-new Tercel due; possibly not in the United States
Corolla	All-new platform, redesigned body, new aluminum 4-cylinder engine			Possible gasoline/electric hybrid for fleet evaluations
Camry		New Camry-based Solara coupe planned		2002 Redesign due
Avalon	Modest facelift, powertrain upgrades			Camry-based Solara convertible
Paseo				Major redesign due; possibly not in the United States
Celica		Major redesign due, aimed at entry-level buyers		
Supra				Cosmetic, powertrain updates expected
Siena	All-new Camry-based V8-powered minivan replaces Previa			
RAV4	Facelift due for '98	Power increase from 4-cylinder engine		2002 New design
4Runner				
Land Cruiser		Stretched wheelbase, redesigned exterior, increased power		
Tacoma Pickup		Improved V6 engine expected		Redesign due mid-2000 as 2001 model
T100 Pickup		Major redesign, new V6 and V8 engines		

VOLKSWAGEN

Beetle	Front-drive Golf-based Beetle lookalike	150-hp 1.8-liter Audi V6 joins powertrain option list		
Golf	Redesigned Golf debuts	New Golf expected in U.S.	Corrado replacement considered	
Jetta		All-new Golf-based Jetta sedan		
Passat	All-new Audi A4-based midsize sedan debuts, 2 new engines	Station wagon model joins lineup; Syncro AWD available		2002 V10 luxury sedan



VW revives the Beetle in midyear '98.

VOLVO

70-Series	70-Series replaces 850; AWD turbo wagon added	240-hp C70 sport coupe available spring '98	C-70 convertible model expected	
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For dependable results it pays to use pro tools like Milwaukee's Power Plus Driver/Drill and Stanley Contractor Grade tape measure.

It pays to use tools made to high standards.

Whenever you build, whether it's with lightweight materials or construction-grade framing lumber, it pays to choose and use tools that are up to the task. Even small jobs like our fence-building project require gear that's built to take some punishment. Holes have to be dug for the posts, nails have to be pounded home, tough pressure-treated wood has to be cut. A jobsite is no place for lightweight, bargain-basement equipment. Professionals and tradesmen know this, and usually pay a premium for the quality tools they use day in and day out.

If you expect to need your tools more than once—and it's a sure bet that if you own a home, you will—it's always a good idea to choose the best that you can afford. For instance, a retractable tape measure which can be found in everyone's tool box or kitchen drawer can be purchased anywhere, and there are lots of cheap products that do the same job. So why go out of your way to buy a better one? Because you can depend on a better tool to last longer and perform consistently.

Better tools usually come with improved features, as well. The Stanley 25-foot Contractor Grade tape measure we used on this and other jobs has a "Maximum Steel" blade that's up to 25 percent thicker than other brand blades, which allows you to horizontally extend the

Even ordinary, everyday tools have improved greatly in recent years due to new and better materials, longer-lasting batteries and computer-aided design. Some tool makers have also discovered that consumers today know and want higher quality products.



The ultra-thin kerf 5 1/2-in. blade on the new Craftsman Industrial 18-Volt Trim Saw maximizes battery power for longer run-time and more cuts.

tape up to 9 feet—a feat that takes on critical importance when you work alone. Our fence posts are spaced 8-ft. on-center, and the Stanley tape allowed us to measure off the distance without having a helper stand by on the opposite end.

You don't have to be a contractor or tradesman to appreciate the value of another tool we used for the first time on this job—a RoboLaser "laser pointing system." Anyone who has watched a construction crew recently has probably seen them using laser beacons—expensive, highly-accurate devices that project a ruby-red beam of light and make quick work of leveling forms and materials over great distances. The complexity and high cost of these devices has put their usefulness out of reach of most non-professionals until now. RoboLaser is a breakthrough product that has a uniquely simple operating system, and is available at a cost that makes it practical for anyone with a need for this kind of tool.

One of the most time-consuming aspects of construction work, especially when working outdoors on uneven ground, is the initial layout of the jobsite. For a project like ours, this typically entails setting up a tripod-mounted builder's level, pounding in stakes and constructing temporary batter boards,

continued on page 109

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Automatic Out of Level Sensing! RoboLaser has a built-in level sensor. If the unit is bumped or disturbed after initial setup and goes out of level, the laser will begin blinking.

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The key to RoboLaser's ease of use is the remote controlled hand unit. This feature lets you aim the dot by remotely rotating the precision step motor that drives RoboLaser while you stand next to the target. In just minutes, using RoboLaser & a chalk snap-line, interior carpenters can layout an entire room with perfectly level reference lines for countertops, window installations, and trim work. RoboLaser is also ideal for masons in setting forms for foundations, laying tiles, & building up cinder blocks. Framers will find that the time they save in leveling out headers and ridge beams will pay for RoboLaser in a day. Plumbers setting grades for drainage lines will never to a jobsite without RoboLaser again. **Call & order RoboLaser today! FREE CARRYING CASE included for a limited time only. PS10P**

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A Powermate 1000 provides electrical power for tools or jump-starting batteries. Ace Brand tools and pump sprayer made fence building—and applying Thompson's Fence Care—an easy project.



nd easier.

and stretching a line with a bubble level attached—just to get started. With a RoboLaser, none of that is necessary. The unit is self-leveling, so setup is a snap. Because RoboLaser comes with a wireless remote-control, it allows you to stand next to your work target and aim the laser beam from up to 150 feet away. The beam projected by this unit is accurate to within 1/8th of an inch at distances over 100 feet. We used it first to layout the post holes, and later to align the posts and level off the board tops. For any work that requires layout and leveling a RoboLaser can add precision and eliminate frustration.

Professional-grade tools come in handy on home-improvement projects in other ways. Ever since the "cordless revolution" began, the most capable battery-powered tools were those made for professional use. Tradesmen who make their living with this equipment demand tools that meet high standards. Portability is a major requirement, especially when working in difficult areas like on a roof or scaffolding where an electrical cord not only can be a hindrance to movement, but a dangerous obstacle as well. Cord-free also means freedom of movement, with lighter equipment to carry and operate. And although early battery tools suffered from low power, long recharge times and limited battery life, today's best cordless tools show no such weaknesses.

One tool we depended on throughout our project was a Milwaukee 14.4-Volt Power-Plus 1/2-inch Driver/Drill. We found it almost

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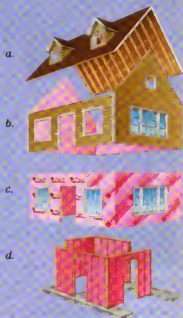
Isn't it remarkable how similar coordinating a kid and coordinating the exterior of your home can be? Just like a parent thinks of everything for the kids, the Owens Corning Exterior System covers all the bases for your home's exterior.

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SYSTEM THINKING
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Portability is one benefit of cordless tools. Our Craftsman Industrial 18-Volt Trim Saw and Skil Flexi-Charge Finishing Tool also offer convenient size and weight, yet they deliver full-featured performance.

Better tools are generally stronger and more powerful, but they can also be smaller and well-designed to work in difficult-to-reach places where bigger, clumsier tools can't go.

Cordless tools deliver plug-in performance.

impossible to wear down the battery, even after long days of hard work. With its quick one-hour recharge time, this wouldn't be a problem on any jobsite. And with two variable-speed ranges and up to 280 inch/pounds of torque, this tool didn't find a screw or bolt it couldn't turn. Other quality features included a soft-grip handle pad that reduces vibration, a well-balanced ergonomic design and a unique battery pack that can be turned around to change the balance or improve clearance in a tight spot.

Of course, not everything powered runs on batteries, and even battery-charging systems need to plug into a power source. For just these reasons, another much-used item in our tool kit—on the job, on our boat, on vacation, and just about anywhere we go now—is our Coleman Powermate 1000 portable generator and battery booster. The convenience and usefulness of this compact, gasoline-powered unit is nothing short of amazing. Unlike typical generators, even small ones, which are big and bulky and weigh as much or more than one person can lift, the Powermate 1000 weighs only 22 lbs, is about the size of an ordinary breadbox, and can be carried in one hand. But like many generators twice its size

and cost, the Powermate 1000 can produce a continuous 850 watts of AC power, enough to run small electrical appliances, power tools or emergency lighting.

This unit also is equipped with specially-designed jumper cables that can jump-

start a car or boat battery in seconds—a very useful feature when you're on the road or far from the nearest service shop. Another smart feature of the Powermate 1000 is that it incorporates an advanced microprocessor system that shuts down automatically when it detects a power overload or reverse polarity, protecting itself and other costly equipment.

Whatever kind of home-improvement or repair projects you tackle around your house, you will always do a better job if you use the right tools. The "right" tool, of course, is not only the proper tool for the work at hand but also a well-made tool that's suited to the task. Although it still holds true that "a poor workman blames his tools," it's also true that a quality tool can help you to do better work, while a cheaply made tool can contribute to mistakes, damage the costly materials you're working with, and even cause injury.

One way to know that you're getting quality in tools is to choose the more expensive professional-grade tools. Another way is to buy from a source that backs its products with a solid, lifetime guarantee. Ace Brand hand tools offer an alternative that gives you the best of both. Not only are all Ace Brand

continued on page 114



The twin batteries in this Skil Finishing Tool can be used to power other tools in the Flexi-Charge System. This makes it easy to carry several tools to the job, and only one charger is needed.

The ACE logo is located in the top right corner of the advertisement. It features the word "ACE" in a bold, white, sans-serif font, with a red outline. The logo is set against a dark red background that is part of the top banner.

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Whenever you apply finish to a softwood like this pine bench, first apply a coat of Minwax Wood Conditioner to slow the absorption of the stain.

For a fast, one-step finish and topcoat, we used Minwax Polyshades, which has stain and polyurethane blended together. Nine colors are available.

Brand-names you trust deliver consistent results.

tools and products certified by independent testing to be as good as—or better than—the leading national brands, but they also come with both a buyer-satisfaction guarantee and a full lifetime warranty. You can be assured of getting superior quality and craftsmanship, as well as exceptional value because Ace Brand products are priced well below competing national brands.

There was a time when home owners thought outdoor wood decks didn't require any care, because the woods they used were supposed to weather naturally or were chemically treated to resist water, rot and insect damage. But many owners learned the hard way that wood continually exposed to sun, rain and freeze/thaw conditions can't last indefinitely and look its best without ongoing preservative treatment.

The deteriorating effect of the elements are plain to see on the existing privacy fence in our yard, so when we decided to extend the fence along our property line, we used new Thompson's Fence Care products on both the new and old sections. This two-step product includes a Fence Wash that cleans away dirt, mildew, algae and airborne pollutants without bleach, and prepares the wood for treatment. The second step is

Our sunroom bench was a fun project with great results. Building kit furniture is the kind of home-improvement project anyone can do. Kits are available in many stores and catalogs, and most require some surface preparation, finishing and assembly.



You can't blame the tools if you do a poor job, but quality tools will help you do better work. All Ace Brand hand tools are satisfaction guaranteed with a lifetime warranty.

Thompson's Water Seal Fence Finish, which includes a protective waterproofing with a cedartone finish that blocks graying from the elements on both new and refinished wood. Both products can be applied using an inexpensive, easy-to-use pump sprayer, so that even a long stretch of fence like ours can be treated and finished in a day.

As we said earlier, working outdoors can be difficult under the best of circumstances, but life has gotten much easier around construction sites since the introduction of cordless tools. Nowhere is this more evident than in the use of battery-powered saws. Five years ago, even the experts doubted that cordless saws could ever compete with corded tools in terms of raw torque output and run time. One major problem existed that seemed to forever limit their ability—batteries just weren't available that could store and deliver the continuous power needed to push a blade through thick dimensional lumber.

Well, that's not true anymore. A new standard was recently introduced that all saws—cordless or otherwise—will now have to compete against in terms of power and ability: the Sears Craftsman Industrial 18-Volt Trim Saw. Many owners will agree that it may be a

Elmer's makes the perfect something for practically everything.



No matter where in your house you look, whether it's something you want to do or something you need to fix, Elmer's® has the answer. From glues to wood fillers, caulks to contact cements, Elmer's is the one name you need to know to get the job done right. And get it right the first time. So for your next project or repair, trust Elmer's and you'll get perfect results every time.



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SPECIAL ADVERTISING SECTION

Not all measuring tapes measure up to Stanley's Contractor Grade 25-ft. tape. Its wide "Maximum Steel" blade extends unsupported to 9 feet.



misnomer to call this tool a trim saw, because it is capable of much more than the name implies. At 4,000 rpm, its 5 1/2-inch, ultra-thin kerf blade can cut clean through 130 standard 2x4s, or 135 feet of 1/2-inch plywood, on a single charge. And because the saw comes with two heavy-duty 2.0 amp-hour battery packs and a one-hour "smart" charger, it's hard to reach the limit of its power supply.

Not all fall home-improvement projects are outdoors. On our job list this year are building and refinishing a bench for the sunroom, and adding another layer of attic insulation to increase our home's energy efficiency and reduce our energy costs.

Building furniture from a kit is a fast, easy way to add to your home's furnishings. But our pine storage bench required considerable sanding and surface preparation before we could add the finish stain and topcoat. The best way we found to do this job was with a Skil Flexi-Charge Finishing Tool. Unlike typical plug-in powered sanders,



this handy cordless tool is slim and lightweight, which enables it to reach into narrow spaces to sand surface details and intricate shapes. And because its sanding pads are attached with hook and loop backing, they are quickly and easily replaced. The 7.2-volt Model 2425 Finishing Tool has a direct drive for maximum energy efficiency, and it operates with orbital action at two speeds—6,000 orbits per minute for coarse sanding, or 12,000 orbits per minute for fine finishing. It comes with a 3-hour charger and two batteries that are interchangeable with other tools in the Skil Flexi-Charge System, which includes cordless screwdrivers, drill/drivers and flashlights.

Something else that helped to speed this project along, and gave us the high-quality results we wanted at the same time, was finishing our bench with Polyshades, a one-step wood stain and polyurethane product from Minwax.

continued on page 116

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SPECIAL ADVERTISING SECTION

Some things just make life easier—Pink Plus insulation's Miraflex fibers are itch-free, and Arrow's E-Z Pull Twister riveter gets into places other tools can't reach.



Save costs by doing it yourself

You can literally cut your work in half with Polyshades, because you eliminate having to first stain the wood and let it dry before you can apply the finish coats. The same rich Minwax stain colors are preblended into the polyurethane, so it all goes on together, and you can be done with all of the work the same day. Polyshades may be used over new wood, or over previously stained wood with no stripping required.

For our bench, we chose a rich red Bombay Mahogany finish. A total of nine different Polyshades stain colors are

There are other advantages to Owens Corning Pink Plus insulation besides ease of installation. Its soft Miraflex fibers compress easily, so rolls can be bundled smaller and are easier carry into cramped crawlspaces and attics. They load easily, too. We couldn't fill the cavernous interior of this Chevy '97 Utility Van with all the insulation rolls we needed for our attic, and we still had plenty of room for fence posts, boards and hardware.

continued on page 16





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available. Any of these finishes may be used on any type of wood, but on softwoods such as our pine bench, pretreating the wood with Minwax Pre-Stain Wood Conditioner is recommended. Brush the Conditioner on freely, wait a few minutes for it to soak into

the wood surface, wipe off the excess and let dry, then begin brushing on Polyshades. This step prevents soft, porous woods from absorbing the stain too quickly, and allows you better control of the amount and depth of stain color. Most hardwoods don't require pre-stain treatment, but it's always smart to test the stain first on a scrap of wood or an out-of-view section before.

Getting a home ready for winter is an important seasonal task. Yard furniture, barbecues and other summer items have to be stored away, shrubs need protection against frigid winds and foraging deer, vehicles have to be winterized, and the list of things-to-do goes on and on.

Sealing out drafts, having the furnace serviced, and checking that your home is adequately insulated are among the chores home owners should attend to now. One of the easiest ways to improve a home's energy efficiency, and save on heating costs at the same time, is to add or upgrade attic insulation. As much as 40 percent of a home's heating energy is lost through the attic. There is a solution, however—Owens Corning Pink Plus Insulation featuring Miraflex fiber. Unlike the fiberglass used in other



The curved, open louvers of the Rainhandler System intercept rainwater and melting snow and direct the droplets away from house walls.

insulation brands, Miraflex is soft and virtually itch-free, and because each batt is completely enclosed in a smooth polywrap sleeve, installing it is easier and more comfortable. The rolls are also compressed to compact size so they're more convenient to handle and transport from the store to your attic. Pink Plus is available in R-25 rolls for attics and crawlspaces (most homes need R-38, which is equal to a 12-inch-thick fiberglass blanket), so upgrading your home to meet today's energy guidelines can be done in one fast operation.

One do-it-yourself job we won't have to do this fall—or ever again—is get up on a ladder or onto the house roof to clean out gutters and downspouts clogged with leaves, ice or snow. Typical gutter systems are always a

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*Patent Pending

problem because everything that passes through them can accumulate over time and cause these systems to fail, particularly when temperatures fall below freezing. When this happens, rainwater and melting ice overflow the gutters and cause damage to plants, landscaping and house foundations below. And the only way to solve this problem is to climb up and clean out the gutters or disassemble the leaders and downspouts

to remove the blockage.

The Rainhandler Rain Dispersal System is an alternative to this, however. This system of open louvers, installed just below the drip edge of a roof, intercepts the flow of water without blocking it or carrying it off to downspouts. As the water hits the louvers, it breaks up into small droplets which disperse naturally over a wide area away from the house walls. The rugged, all-aluminum

HOME
Remodeling
IDEAS

Rainhandlers are designed for years of service and carry a 25-year warranty. Available in three colors, their low-profile design is so unobtrusive they become almost invisible and there is virtually no maintenance or cleaning needed.

continued on page 120

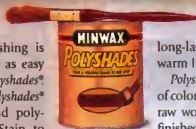


Installation of Rainhandler Rain Dispersal System can easily be managed with a drill, hand tools and some occasional assistance. The slim profile of the louvers make them almost invisible in front of the soffits.

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The most useful tools and products have many uses. This Arrow riveter (above) has a swiveling head to reach into tight places, and adapts to a wide range of rivets for different jobs. Our Chevy '97 Conversion Van is as rugged as our utility van, so it can haul and tow heavy loads when needed, but offers a comfortable ride for family outings or touring. ProBond Ultra Polyurethane Glue bonds virtually anything, straight from the bottle.



Versatile products help wherever needed.

Most home owners have an adequate supply of hand tools for around-the-house chores, including a hammer or two, screwdrivers, adjustable and socket wrenches, tape measure, pliers of various sizes, levels, staple gun, and so forth. But there is another tool that can be used for a wide variety of repair work, and is often the only tool you can use for specific jobs. If you don't own a rivet tool, you may not realize how useful it can be.

For example, what else quickly and permanently repairs metal objects like lawn furniture, mailboxes, heating or air conditioning ductwork, sheet metal cabinets, and garden equipment? You might try using nuts and bolts, or tape, or screws, but often as not the right way is to use a rivet. And now there's a new rivet tool with a unique, 360-degree swiveling head that makes it easier to put rivets in those tight, hard-to-get-at places where you need them the most. The Arrow E-Z Pull Twister Professional Model RHT300 lets you rivet in corners, behind eaves, behind a furnace and wall, and around other obstructions. We used it in just such a place to install new heating ducts, and even to do a quick fix on our mailbox. The RHT300 also comes with a wrench and interchangeable nosespices that allow you to use different-size rivets for different

tasks. And there's a wide selection of rivets available for most jobs and materials such as steel, aluminum, canvas, leather and more.

And there are other times when the only way to repair something is to



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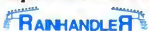
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AS POPULAR SCIENCE

Why do people's eyes sometimes appear red in photographs?

Randall S. Tracy
rst@ida.net

WHAT IS KNOWN as "red eye" is a reflection of light off the retina, the tissue that collects images at the back of the eye and transmits them to the brain. Red eyes in photographs are often the result when the picture

EDITED BY CECILIA WESSNER

Research by John Fredericks,
Sharon Parmet, Noah Rothbaum,
Bob Sillery

is taken in low lighting with a flash. When lighting is dim, the pupil dilates to let in more light. This includes the bright light from the flash, which is reflected off the retina. Because of the number of blood vessels found in the retina, the light reflected appears red, giving human subjects that somewhat possessed look.

Many camera models from leading manufacturers incorporate red-eye reduction devices that emit a beam of light before the flash goes

off to constrict the pupil and limit the amount of light that's reflected by the retina.

Why, when we look at an automobile driving forward on a television or a movie screen, do the wheels appear to be moving backward?

Richard S. DiVincenzo
Buffalo, N.Y.

THE OPTICAL ILLUSION you refer to describes the stroboscopic effect.

HOW IT WORKS

The Microwave Oven

MICROWAVE OVENS—marking their 30th anniversary this year—work by exciting water molecules within food. Engineer Percy Spencer got the idea to cook food with microwaves when he toured a Raytheon laboratory that produced magnetrons for military radar systems. He noticed that co-workers warmed their hands in front of the magnetrons, so he tried using the devices for popping popcorn. That led to a patent. The rest is culinary history.—*Judith Anne Gunther*

1 In the magnetron, a tungsten wire (the cathode) is surrounded by a series of copper bars (the anode). When the tungsten wire is heated, electrons are excited and flow to the copper.

2 A magnet produces a magnetic field, bending the electron flow. With the right voltage and magnetic field, the flow resonates. A bit of copper on one anode bar converts the current into an electromagnetic wave.

3 An aluminum conduit, or wave guide, directs the microwaves toward the cooking chamber.

4 An aluminum fan deflects the microwaves as they enter the cooking chamber. This helps prevent microwaves from canceling each other out, which causes uneven cooking.

5 The oven chamber is lined with stainless steel. When the microwaves enter the chamber, they bounce off the walls and into the food, warming it.



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Bruce Jackson, a professor of film at the State University of New York at Buffalo, explains how this effect is created: "Film is composed of a series of still photographs. Movement is created in film similarly to how cartoons are animated. A series of still photos are shown one after the other, creating apparent movement. These photos are taken at intervals between 24 and 60 frames per second, depending on the medium [television, film, video]. If the movement [wheels rotating] does not correspond with the frequency at which the photos are taken, the appearance of the movement will be misrepresented."

The speed of the film frames and the speed at which the wheels turn determine the direction in which the wheels appear to be moving. Film taping at 40 frames per second, for example, might make the wheels of a car appear to move backward, while film taping at 30 frames per second might make the wheels appear as if they're moving forward. Likewise, under constant film speed, the wheels of a car moving at 30 miles per hour might appear as if they're moving in reverse while the wheels of a car traveling at 40 miles per hour might appear as if they're moving forward. In each subsequent frame of the film, the wheels might be a little behind where they were in the previous frame. This causes the wheels to appear as if they move backward.

How does a mirror reflect images?

Eddie Kay
AiYU@aol.com

THE FIRST STEP in understanding how a mirror works is learning how it's made. First, a smooth piece of glass is coated on one side with a solution of ammonia silver. It's then treated with a reducing agent, commonly formaldehyde. The two compounds chemically react, producing metallic silver. The glass now appears shiny and reflects the light

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that enters it directly outward.

"We have all heard it said that light travels in straight lines," says Albert A. Bartlett, retired professor of physics at the University of Colorado in Boulder. "These straight lines are called rays." The rays keep going straight, he adds, "until something reflects or refracts [bends] them." When a ray of light strikes the reflecting surface of a mirror, it is reflected. The angle at which the ray hits the mirror is called the angle of incidence. The angle at which it is reflected from the mirror surface is the angle of reflection. The fundamental law of reflection is that these two angles are equal. "One sees a similar situation when billiard balls bounce from the cushion at the edge of the billiard table. The angle of incidence of the ball on the cushion is equal to the angle of reflection

of the ball from the cushion."

Mirrors with convex surfaces cause the reflected rays to diverge at a greater angle than they would have diverged on reflection from a flat mirror. As a result, the image is smaller than it appears on a flat mirror of the same size, but a wider angle of view is shown. "In the fun house in an amusement park, the mirrors are curved in complex ways so that different parts of one's image appear to be wildly distorted," says Bartlett. The rays are reflected at either a greater or a lesser angle than they would have diverged from a flat mirror of the same size.

The oldest mirrors found date back to the Etruscans, Greeks, and Romans and consist of a thin disk of highly polished metal, usually bronze. By the Middle Ages, such mirrors were found throughout Europe. During the first century A.D., Roman naturalist Pliny the Elder is credited with first using glass to create mirrors. By 1564, a Venetian mirror-makers guild formed, ushering glass mirrors into the era of commercial production.

With today's advanced engines, is it a good idea to let a car idle warm up for a short time before driving?

*Jack Rohan
Van Nuys, Calif.*

"THERE'S NOTHING to be gained by warming up the car before driving it. In fact, it was never necessary," says Art Nellon of the Car Care Council in Port Clinton, Ohio. The practice was often followed to enable the vehicle to reach a normal idle speed on cold days so the heater could warm up.

Nellon also notes that today's oils are far superior to those of years ago, so cars are even less susceptible to engine damage than they were in the past. It's not a good idea to race your engine when it's cold, however, because the oil has not had a chance to fully circulate and engine damage could occur.

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I have noticed that when an unopened can of cola is left in the sun for some time, it loses its carbonation. Why?

Stefan T. Pietrzak Youngs
stefenp@asu.campus.mci.net

ALL CARBONATED beverages contain two major elements, namely carbon dioxide and water. According to Tom Roziak, a professor of chemistry at the State University of New York in Buffalo, "Both the water and carbon dioxide elements contain a weak electrical charge. This electrical charge forms an attraction between the water and carbon dioxide molecules, allowing the carbon dioxide to remain in solution. This magnetic field is small, so any energy put into the solution will break the bond between the water and carbon dioxide molecules. This energy may be in the form of movement, such as shaking up a can of cola, or in the form of added heat."

In other words, the liquid soda holds less carbon dioxide gas in solution when exposed to higher temperatures, which is what happens when the can is left in the sun. This is true whether the beverage remains inside a sealed container or not. So when you open up a can that's been in the sun for a while, all the carbonation escapes, leaving your beverage "flat."

What causes sleepwalking, and what does a person feel or experience while sleepwalking?

padock@villagenet.com

MEDICAL SCIENCE has amassed a lot of information about sleepwalking, or somnambulism, yet much remains unknown as well. Classic sleepwalking most often occurs in otherwise-healthy children, typically from ages six to 12. The cause? "It's a genetic phenomenon. It runs in families," says Dr. Neil Kavey, director of the Sleep Disorders Center at Columbia-Presbyterian Medical Center in New York. "Now, you can be born with a heavy predisposition

to sleepwalking and never sleepwalk, or you may have a more moderate predisposition and sleepwalk, and we don't know why," says Kavey.

Among the agents that can set off sleepwalking in someone predisposed to it are sleep deprivation, traveling across time zones (because of its effect on sleep), combinations of medications, alcohol, and stress, among others. For reasons that are not fully understood, the parts of the brain that control walking or talking become automatically activated, while the remainder of the brain remains in slumber. Often, a very specific trigger—say, a banging pipe—can stimulate an episode, says Kavey.

The sleepwalker's actions may be simple, such as sitting up in bed or walking about, or more complex, such as dressing and undressing or going to the bathroom. Some sleepwalkers have even driven cars.

Kavey describes sleepwalking as a state "betwixt and between" sleeping and wakefulness. What a person experiences during this state is the biggest mystery of all. The sleepwalker will usually present a blank, staring face and be relatively unresponsive to efforts of others to communicate. When they are awoken, sleepwalkers are rarely able to recall anything about their experience. "We don't know what they've been going through, because they can't tell us," says Kavey.

According to the American Sleep Disorders Association in Rochester, Minnesota, sleepwalking occurs in 10 to 30 percent of all children, and 1 to 7 percent of all adults. ▶

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100 YEARS AGO MORE THAN a century after Benjamin Franklin used a kite to demonstrate the electrical nature of lightning, **POPULAR SCIENCE** recreated his experiment with more sophisticated electrometers. We flew kites from city rooftops (above), even from the Washington Monument. Among the findings: Showers or thunderstorms were not the

only condition yielding marked electrical effects; we had no trouble getting sparks in cloudless skies. And voltage increased as the kite rose.—October 1897

In Praise of Spiders

125 YEARS AGO "SPIDERS ARE only repulsive as long as we are ignorant of them," we wrote. Taking a magnifying glass to members of the spider family (left), we observed their complex structure and ingenious ways. "The spider practices industry, patience, and perseverance. The female is an affectionate parent, very fond of her young,"—October 1872



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Testing Car Bodies

50 YEARS AGO "THIS FORD IS leaping into the air on one of its 200 trips around the 'body-twist' course at the Dearborn, Michigan, test track. In this first of a series of tests, body and frame are subjected to extreme torsion stresses—first in one direction, then the other, as indicated by the whipping aerial."—October 1947

The Dearborn track, converted from an airstrip built by Henry J. Ford, was the company's first testing ground. Previously, testers for the automaker sought open spaces anywhere they could find them, including frozen lakes, says the company. Now one of Ford's three such facilities, the Dearborn test track is still in use.



Message from Venus

25 YEARS AGO "NOW WE know how hot it is on the daylight side of Venus—very hot. The Soviet space probe Venus 8 landed an instrument package in July, and the instruments sent back

information for 50 minutes before falling silent—probably prey to the withering heat and pressure on the Jovian surface. Fortunately, measurements were transmitted before failure: a temperature of 870°F, a pressure equal to 93 Earth atmospheres."—October 1972

Ty Cobb Takes Batting Practice

75 YEARS AGO THIS BATTING PRACTICE pitching machine has its work cut out for it. It's facing one of baseball's greatest hitters, Ty Cobb. As the gentleman at right turned the crank, the revolving arm at the top of the machine swung the ball attached to the cord rapidly in the direction indicated by the arrows. It doesn't look like Cobb had too much trouble putting wood on the ball.—October 1922



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